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An Army Enlistment Early Warning System

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Preface

The Institute for Defense Analyses (IDA) prepared this paper for the Office of the Director, Program Analysis and Evaluation, under a task titled "Army Enlistment Early Warning System." It documents research to develop an Enlistment Early Warning System (EEWS) for the Army. The EEWS forecasts the probability that the Army will achieve its enlistment contracts mission over the next 12 months.

David R. Graham and Stanley A. Horowitz of IDA were the technical reviewers for this paper.

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Summary

The Army responded too slowly to recruiting difficulties caused by the 1990s economic boom. Shortfalls of enlistment contracts emerged in FY 1993–94 and worsened throughout the decade. As a result, accession quality declined in the 1990s and when it could not be reduced any more, an accession crisis occurred in FY 1998–99.

An important reason for recruiting problems was military pay erosion between FY 1993 and FY 2000. Congress finally provided a catch-up pay raise in FY 2002, but by then the United States was in a recession that caused a dramatic turnaround in recruiting. The recession continues in FY 2003 and recruiting resources are now over-budgeted. A similar accession crisis and belated policy response occurred in FY 1978–82.

To help prevent accession crises and better manage recruiting, this study develops an Enlistment Early Warning System (EEWS) for the Army. The EEWS forecasts high-quality enlistment contracts 1-year ahead, with time-series models of Army enlistments, unemployment, and civilian earnings of youth. It uses computer simulation to estimate the probability of contract shortfalls in the forecast period.

To test the methodology, we also developed and tested enlistment models for the other military services. The findings are similar. For all services, enlistments are well explained by relative pay, unemployment, and recruiting resources, and the out-of-sample forecasting error is less than 3 percent.

The recruiting market changes often and DoD needs to understand where it is going. Besides forecasts, the EEWS provides DoD policymakers with a tool for quickly analyzing how economic conditions, policies, and external shocks affect recruiting.

Enlistment forecasts depend on the accuracy of the underlying economic forecasts, which change quickly around business cycle turning points. Therefore, the model should be run monthly to ensure accurate recruiting forecasts.

The Army is now using the EEWS to help manage recruiting incentive programs and to estimate the effects on enlistments of the economy, policy changes, and “shocks” such as the September 11th terrorist attacks. We recommend the Army run the EEWS each month and use the risk analysis it provides to help prevent accession crises and better manage its recruiting program.

I. Introduction

DoD can no longer solely rely on such "lagging" indicators as retention and recruiting rates to detect personnel problems; by the time those indicators highlight a problem, it is too late.

—*Quadrennial Defense Review*, 30 September 2001, p. 59.

A. Background

In response to an enlistment crisis in FY 1978-79, Economic Research Laboratory (ERL) developed an Enlistment Early Warning System (EEWS) for the Department of Defense (DoD) in FY 1984–85. ERL maintained the EEWS until it was discarded at the end of the Cold War in 1989.[1]

In addition to a forecasting system, ERL developed a conceptual framework for enlistment crisis prevention management (Figure 1). It includes the following three components: Automated Monitoring, Management Assessment, and Policy Response. Automated Monitoring (i.e., the EEWS) continuously tracks and forecasts high-quality contracts and signals an alert if there is an expected shortfall. Management Assessment is a working group of analysts who are experienced in military recruiting. To minimize recognition and response lags, these analysts are drawn from all levels of government that authorize recruiting resources. The Management Assessment working group corroborates an alert, evaluates potential recruiting problems, and recommends solutions. If a recruiting shortfall is forecasted, the group recommends resource increases; if an oversupply of enlistments is forecasted, the group recommends resource cuts.

Given a warning, Policy Response acts to prevent a shortfall by quickly taking appropriate actions, for example, adding resources and issuing directives. To minimize recognition and response lags, this component should include regular Secretarial reviews of recruiting, documentation of Planning,

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[1] See EEWS Phase I research (Goldberg, Greenston, Hermansen, Andrews, Thomas, Yates, and Lavery, 1984), Phase II research (Goldberg, Greenston, Hermansen, Andrews, Kennicott, 1985; Greenston, Goldberg, Hermansen, and Andrews, 1985; Hermansen, Andrews, and Kinnicott, 1985; Holmes and Neil, 1985; and Hunter and Goldberg, 1985), and a sample Recruiting Assessment Report (Greenston and Goldberg, 1985).

Programming, and Budgeting System (PPBS) assumptions, and triggers for changing resources if assumptions are no longer valid (e.g., changes in unemployment). It should also include contingency funds[2] and a supplemental funds request process.[3]

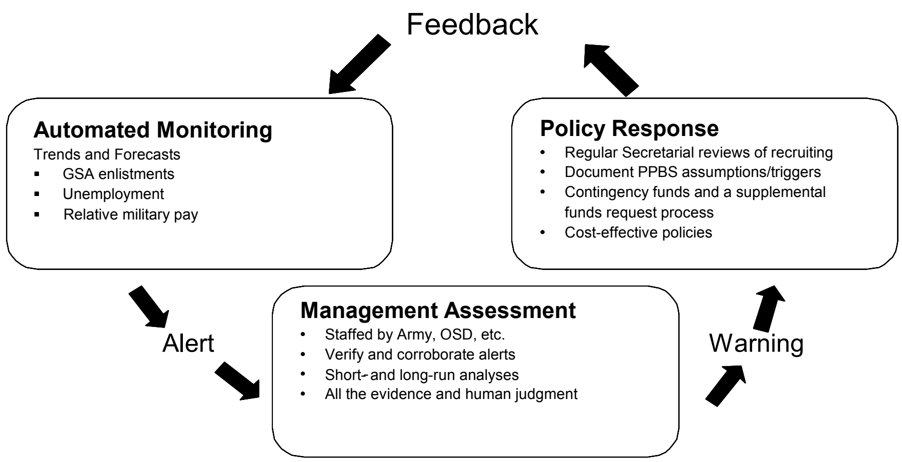

Figure 1. Enlistment Crisis Prevention Management

ERL's EEWS forecasted the number of male GSA (GSMA) contracts.[4] IDA has developed a new EEWS that forecasts both GSMA and female GSA (GSFA) contracts. GSFAs have become a large, critical enlistment cohort whose supply is sensitive to changes in the economy. The new EEWS also estimates the probability of a recruiting shortfall.

B. Objective

This paper describes the updated and refined EEWS IDA developed for the U.S. Army Recruiting Command.

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2 The Army's VIRS Management Decision Package (MDEP), a program managed by the Assistant Secretary of the Army (Manpower and Reserve Affairs) outside the "normal" PPBS process, could be used for this purpose.

3 Systems Research and Applications, a subcontractor, developed a blueprint for the Management Assessment and Policy Response Components but it remained on the drawing board. For details see Hunter and Goldberg (1985).

4 GSA stands for high school graduates and seniors in above-average test score categories I-IIIA of the Armed Forces Qualification Test. For ease of reference, we use Arabic rather than Roman numerals when referring to these categories. Because of high retention and trainability, GSAs are the most desired Army enlistments.

C. Overview of the Army EEWS

Figure 2 is a flowchart of the Army's EEWS. The green areas are the Army Module, which includes Army data and models. Through simulation, the EEWS generates a cumulative distribution function (CDF) for next year's contracts. The CDF is used to assess the risk of recruiting shortfalls. The Army Module also includes a process for generating a risk assessment report. The purple areas depict the Economy Module, which forecasts next year's unemployment and civilian earnings of youth. These are used to forecast enlistments and the CDF.

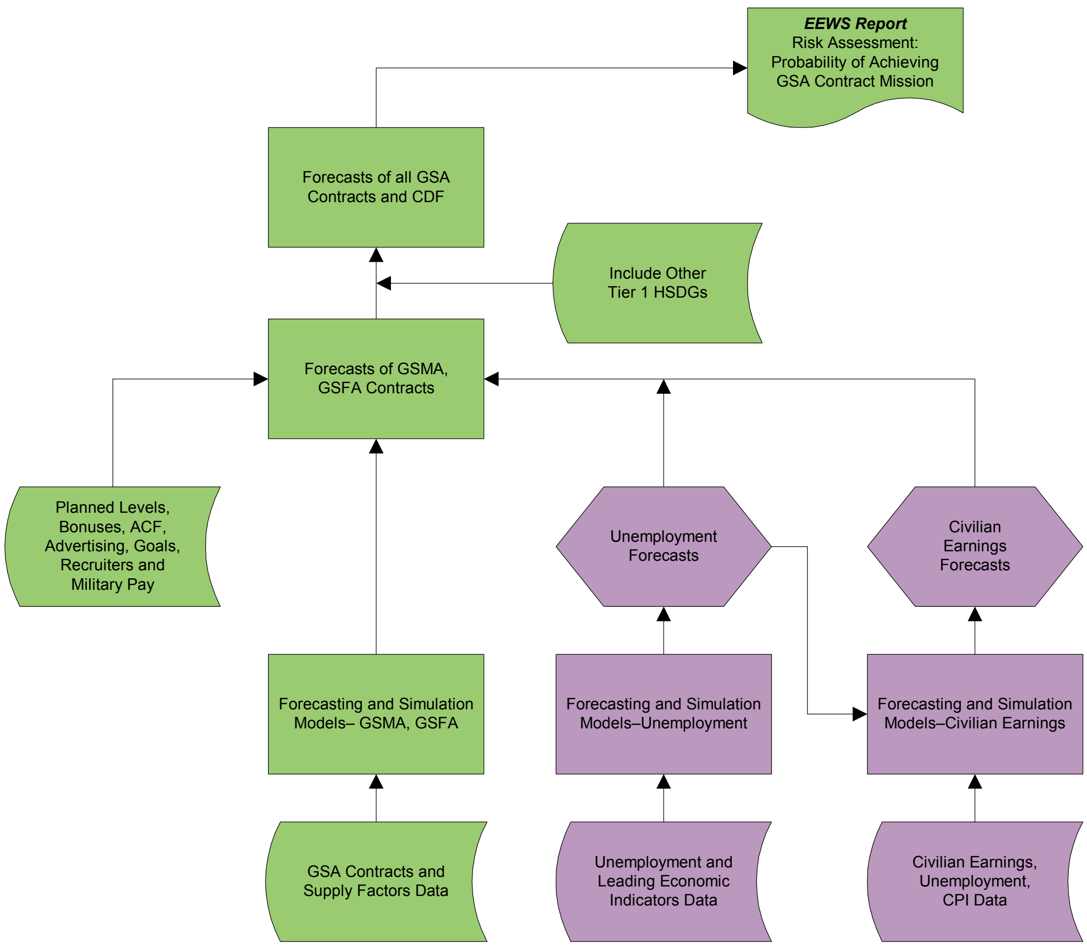

Figure 2. Army Enlistment Early Warning System

Beginning from the bottom of the Army Module in Figure 2, we illustrate how the Army EEWS works. Each month, the system updates historical data on enlistments and supply factors and re-estimates forecasting models for male

(GSMA) and female (GSFA) GSA contracts.[5] It uses the updated enlistment models, planned levels of resources, and updated forecasts of unemployment and civilian earnings (from the Economy Module) to forecast GSA contracts. These are adjusted upward to include "Tier 1" graduates with other credentials, (e.g., 15 hours of college).

The system then generates a probability distribution for GSA contracts through simulation. The last step is the recruiting risk analysis and generation of the EEWS risk assessment report.

D. Format of This Report

The main text of this paper documents the Army GSA models and risk analysis. First we present trends in Army accessions and discuss belated policy responses to shortfalls. We then describe a theoretical model of enlistment supply based on labor supply theory. Next, we specify the GSMA and GSFA forecasting models and present trends in the variables. After that, we estimate the models, undertake forecasting tests, and conduct sensitivity analyses. We then present the risk analysis. The main text concludes with a summary, conclusions and recommendations. Appendix A presents the unemployment model, and Appendix B, civilian earnings growth models by gender. Appendixes C thorough E present GSA models for the other military services.

[5] Contracts are closely related to the economy and provide the best measure of current production for an EEWS. Accessions for the current month are largely drawn from the DEP, (i.e., past production up to one year ago) and are not a good measure of current supply.

II. Background

A. Trends in Accessions

The Army has relied on volunteers for recruits (accessions) throughout much of the nation's history. With the end of the draft in 1973, the Army returned once again to voluntary enlistment. Figure 3 graphs total accessions in FY 1974–02. Due to declines in end strength, total accessions have declined by 63 percent since the end of the draft. Accessions declined from 198,00 in FY 1974 to 120,000 in FY 1989. The end of the Cold War in FY 1989 led to a sharp "draw down" of end strength and accessions in FY 1990–92.[6] In FY 1993–02, accessions averaged 74,000 per year.

As the quantity of accessions declined, the quality increased dramatically. One mark of quality is the percentage of non-prior service (NPS) enlistees who score above average on the Armed Forces Qualification Test (AFQT) given to applicants. AFQT scores are divided into six categories: 1, 2, 3A, 3B, 4, and 5.[7] Applicants in categories 1, 2, and 3A are considered above average; these applicants are more easily trained in a variety of military jobs. The proportion of NPS accessions in categories 1–3A increased from 55 percent in FY 1974–75 to 78 percent in FY 1992 (Figure 3). It declined from 70 percent in FY 1993 to 63 percent in FY 1999. Reversing trend after that, it climbed to 70 percent in FY 2002.

A second quality mark is the percentage of NPS enlistees who are high school diploma graduates (HSDGs). High school graduates have lower first-term attrition than non-graduates. The proportion of NPS accessions that were HSDGs increased from 54 percent in FY 1974–75 to 100 percent in FY 1992. It fell to 95 percent in FY 1993–96 and to 90 percent in FY 1997–99.

Overall, quality peaked during the draw down (FY 1990–92). Largely due to fluctuations in the economy, quality declined in FY 1993–99 and then increased in FY 2000–02. Quality was relatively high in FY 2002—much better than at the end of the draft.

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6 While most of the draw down occurred in FY 1990–92, there were also small reductions in FY 1993–95.

7 For more discussion on quality dimensions, see Bowman, Little, and Sicilia (1986, pp. 29–32).

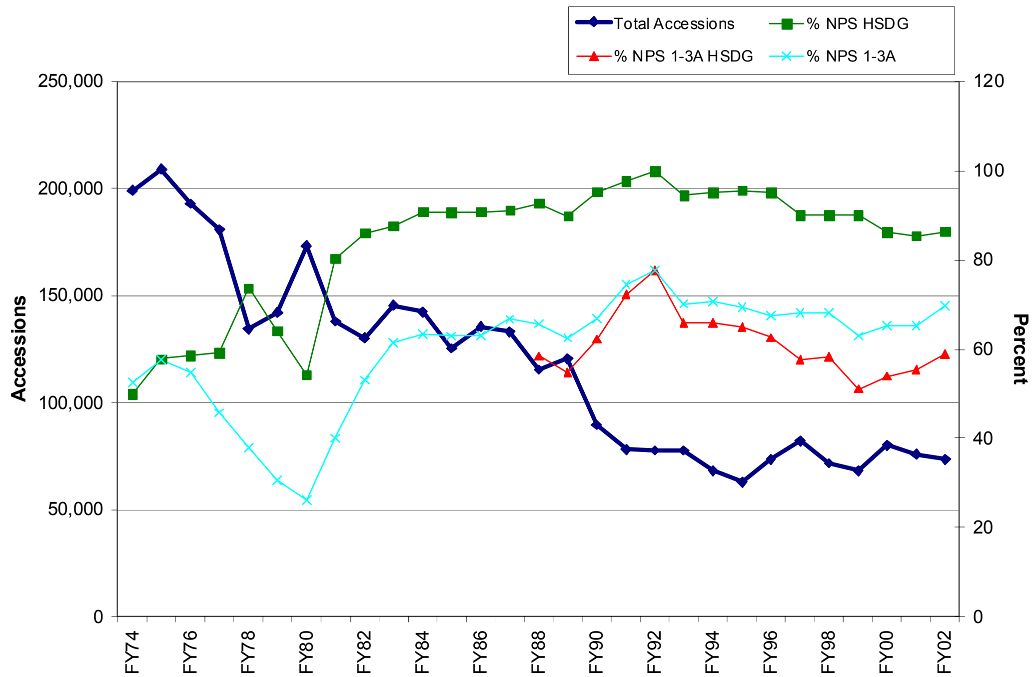

Figure 3. Trends in Army Total Accessions and Quality Marks

In FY 2000–02, the Army recruited about 4,000 above-average recruits with a Graduate Equivalency Diploma (GED). Under the "GED Plus Program," these enlistees are not counted against the NPS HSDG quality mark. Without them, the HSDG percent was 91 in FY 2000–02; with them it was 86 percent. Figure 3 includes the GED Plus Program recruits in the quality marks.

The most desired recruits are HSDGs in categories 1–3A. Data on these recruits are available since FY 1988. The 1–3A HSDG proportion of accessions that were both HSDGs and in categories 1–3A was 57 percent in FY 1988–89. After peaking at 78 percent in FY 1992, it fell sharply to 51 percent in FY 1999 and then reversed trend to increase to 59 in FY 2002.

Figure 4 graphs the percentage of the accession goal achieved in FY 1974–02. In most years, the Army achieved more than 99 percent of its total accessions goal in each year. Significant shortfalls occurred in only 4 years: FY 1978 had a 1.9 percent shortfall; FY 1979, 10.7 percent; FY 1998, 1.1 percent; and FY 1999, 8.4 percent.[8]

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[8] The Navy had an accession shortfall of 7,000 in FY 1998; the Air Force a shortfall of 1,700 in FY 1999 (Hauk and Parlier, 2000, p. 74). The Marine Corps did not have shortfalls in the 1990s, but accession quality declined. The U.S. Army Reserve also experienced serious recruiting problems in FY 1999.

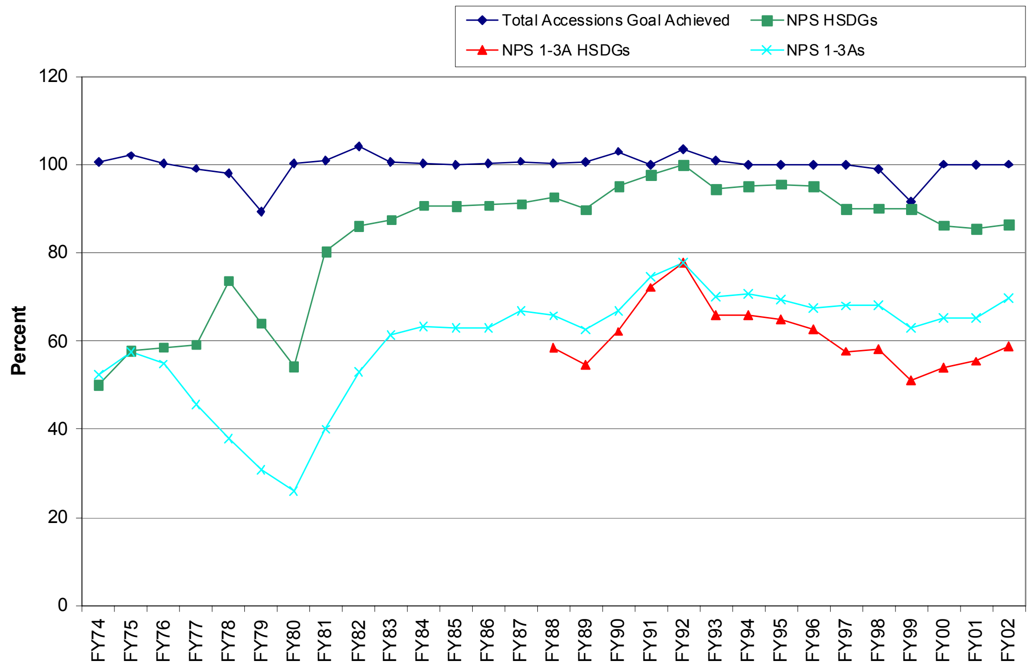

Figure 4. Percentage of the Army Accession Goal Achieved

Figure 4 also graphs accession quality marks. Declines in quality occurred before and during the accession shortfall years. The percentage of accessions in categories 1–3A declined in FY 1976–79 and FY 1993–99. While the percentage of HSDGs *increased* slightly in FY 1977–79, this is an anomaly that occurred because the entrance test was flawed (unqualified recruits were accepted). The HSDG percentage dropped from 95 percent in FY 1996 to 89 percent in FY 1999. The percentage of accessions that were HSDGs and in categories 1–3A declined from 66 percent in FY 1993 to 51 percent in FY 1999. Quality marks declined in FY 1989 and would have declined again in FY 1990 had it not been for the draw down.

B. Shortfalls of Enlistment Contracts

Accessions are generated by enlistment "contracts." Contracts that do not immediately begin service enter a delayed entry pool (DEP); most of these accessions begin their service within a year, but some drop out (attrition). Attrition leads to a decline in the DEP and eventually to an accession shortfall.

High school graduates and seniors in test score categories 1–3A are referred to as GSAs (for Graduate or Senior, 1–3A). The U.S. Army Recruiting Command (USAREC) develops a mission for GSA contracts as a function of the accession goal for HSDGs in categories 1–3A, expected GSA DEP losses, and the desired change in the GSA DEP (the end of this year versus the end of last):

GSA Mission (t) = 1–3A HSDG accession goal (t) + GSA DEP losses (t)
+ Desired GSA End-of-Year DEP (t) – actual GSA End-of-year DEP (t-1). (1)

Current policy is to set the desired GSA End-of-Year DEP (t) equal to 35 percent of next year's accession goal for HSDGs in categories 1–3A.

Figure 5 graphs GSA contracts in FY 1992–02, and USAREC's GSA mission based on Equation (1) and current policy. Contracts were greater than the mission in FY 1992. Shortfalls of 1,000 to 2,000 occurred in FY 1993–94. The shortfall increased to 5,000 in FY 1994 and worsened each year until FY 2001.[9]

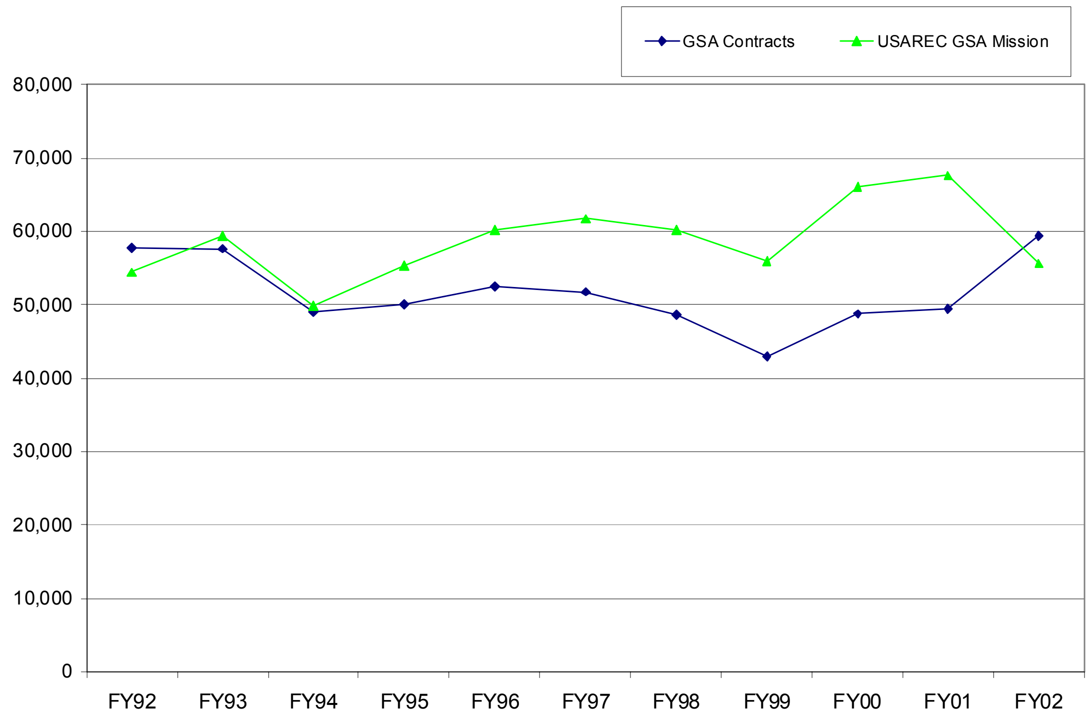

Figure 5. GSA Contracts and USAREC's GSA Mission

A sharp turnaround occurred in FY 2002. Because of increases in unemployment, pay, and recruiting resources, GSA contracts exceeded USAREC's mission by 7.7 percent. The EEWS forecasts that unemployment will remain high in FY 2003. Given forecasts of unemployment, relative pay, and planned levels of resources, GSA contracts are forecasted to exceed the mission by 30 percent in FY 2003.[10]

9 Contract shortfalls also occurred for the Navy in FY 1998–00 and the Air Force in FY 1999–00.

10 For details, see Table 18

C. Recruiting and Retention Crises

In FY 1978–79 all the military services missed their accession goals and recruit quality declined. Many felt the All-Volunteer Force (AVF) was a failure and called for a return to the draft. Former Secretary of Defense Caspar W. Weinberger wrote (Bowman, Little, and Sicilia, 1986, p. 1),

> [O]ur military leaders saw dramatic declines not just in the quality of our new recruits, but also in the morale of career personnel. The peacetime All–Volunteer Force, many concluded, was an unsuccessful experiment, and it was time to draw it to a close.

In FY 1998, the Army missed its annual accession goal by 800 (Hill, Fancher, and Parlier, 1999, p. 6). The shortfall increased to 6,300 (1.5 percent of end strength) in FY 1999, and it was expected to balloon to 17,500 accessions in FY 2000 (Parlier, Hoscheit, Knowles, Lyman, Ayer, and Fancher, 2002, p. 78). Recruiting was becoming a binding constraint on the Army's ability to support national security (Hawk and Parlier, 2000, p. 74, and Parlier et al., 2002, p. 78). In congressional testimony, the Army Chief of Staff, General Eric Shinseki, testified (Parlier, et al., 2002, p. 78).

> I've got to go and fix my recruiting challenge. We came up short last year…. [I]t's hard for me to make an argument for more end strength even though the analysis makes the case, if I can't demonstrate we can recruit.

The problem in FY 1978–79 and FY 1998–99 was not just accession shortfalls. It was also retention, which declined before and during these periods. DoD turned to accessions to fill vacancies left by skilled personnel. When further declines in accession quality could not be tolerated, there were accession shortfalls and *small* deviations from end strength.

To focus attention on these emerging manpower and personnel challenges, the Military Operations Research Society (MORS) held a mini-symposium, "Military Recruiting and Retention for the 21st Century," in September 1999. The Secretary of the Army, the Honorable Louis Caldera, delivered the keynote address and highlighted the serious recruiting *and* retention issues the Army and DoD face. The problem was summarized in a subsequent *Phalanx* article (Thie and Fossett, 1999, p. 24):

> The military services are experiencing difficulty recruiting and retaining the numbers of qualified enlisted people necessary to meet operational requirements and end strength. Recent recruiting efforts sometimes have not met goals, and military personnel are opting to leave some services at rates higher than required to maintain adequate experience levels.

This study focuses on preventing accession shortfalls—one component of a recruiting and retention crisis.

D. Why Accession Shortfalls Occur

The military competes with the private sector for personnel. When the economy expands, civilian pay and benefits grow rapidly and unemployment declines. This causes enlistment supply to decline. Retention also declines and this leads to higher accession goals. Accession shortfalls have occurred because military pay and recruiting resources were added too late to offset the decline in enlistments and increase in accession goals.

DoD's Planning, Programming and Budgeting System (PPBS) and the Congress respond to recruiting resource shortfalls (or abundance) by adding (reducing) resources and enlistment incentives. However, they fix last year's problem next year (and the year after that). Recruiting resources are adjusted too slowly—not enough when the economy expands and too much when it contracts. This has caused a recruiting boom-and-bust cycle roughly once a decade.

E. Accession Shortfalls and Policy Responses in FY 1979–82

Severe recruiting problems emerged in FY 1978–79 due to declines in unemployment and relative military pay (Goldberg, Sep 1982).[11] The PPBS added recruiters in FY 1980, and the Congress increased military pay, bonuses, and education benefits in FY 1981–82. But by FY 1982 there was a severe recession and the extra resources were not needed.

F. Accession Shortfalls and Policy Responses in FY 1998–03

An unprecedented economic boom occurred during FY 1993–00. Unemployment and relative military pay declined more or less continuously, and this reduced enlistment supply. Recruiting problems (i.e., declines in accession quality and GSA contract shortfalls) emerged for the Army in FY 1993 and worsened after that.

The Army's response was to incrementally add resources as follows: recruiter and advertising increases started in FY 1994; bonuses, in FY 1997; and

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11 Another problem was that the entrance test, the Armed Services Vocational Aptitude Battery (ASVAB), was too easy to pass (misnormed), and this resulted in too many category 3B and 4 enlistments (Bowman, Little, and Sicilia, 1986, pp. 31–32).

education benefits, in FY 1998. But throughout the decade the Army's response was "a day late and a dollar short." Finally, there was an accession crisis in FY 1999.[12]

Because of increases in unemployment, military pay, and recruiting resources, the GSA contract mission was achieved in FY 2002. However, resources remain high in FY 2003 despite a continuing recession and declines in the GSA mission.[13]

The Army experienced accession shortfalls in FY 1978–79 and FY 1998–99 because it added recruiting resources too slowly when the economy expanded. Resources were then over-budgeted during the subsequent recessions. In general, recruiting resources lag because the PPBS responds to the previous year's problems.

An innovative alternative approach called crisis prevention management would use forecasts of enlistments to more quickly allocate resources as needed over the business cycle. Crisis prevention management requires an EEWS to forecast recruiting difficulties and a management system that responds more quickly to changes in recruiting.

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12 Like the Army, the Navy and Air Force incrementally added recruiters starting in the year *after* they first had contracting shortfalls. Fortunately, due to smaller accession requirements, their problems were not as severe as the Army's.

13 The GSA mission declined in FY 2003 because of the large DEP build up in FY 2002.

III. Forecasting Models for Army Enlistment Contracts

A. Labor Supply Framework

1. Relative Benefits

Early studies assumed enlistment was a labor supply decision that depends on the relative pecuniary and nonpecuniary benefits of military and civilian jobs.[14] Later studies added job information and recruiting effort variables (i.e., recruiters, advertising, and goals). We also use a labor supply framework that includes job information and recruiting effort variables.

We assume an individual chooses an optimal sequence of jobs over a lifetime. He/she ranks jobs based upon expected current and future net benefits—pecuniary and nonpecuniary. The latter includes working conditions and intangibles such as patriotism, operating tempo, barracks life, and so on.

We define $U_{Army}(A, J_A)$ as the expected utility of a sequence of jobs that includes Army enlistment A and post-service employment J_A.[15] $U_{Civilian}(C, J_C)$ is the utility associated with an alternative sequence of jobs. It includes pursuing a civilian alternative C over the first term and then an optimal sequence of jobs J_C. An individual will enlist if the utility of Army enlistment is greater than that of the civilian alternative, as follows:

$$U_{Army}(A, J_A) > U_{Civilian}(C, J_C). \qquad (2)$$

$U_{Army}(A, J_A)$ includes factors such as pay, educational benefits, bonuses, occupation, term-of-service, and future job opportunities. A change in a factor, pecuniary or nonpecuniary, that increases the relative benefits of enlistment increases enlistment supply. We do not observe the utility of a job, only the choice that is made.

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14 The first studies, Fisher (1969) and Gray (1970), were based on the theory of equalizing wage differentials, which was articulated later by Rosen (1986).

15 Civilian jobs are defined broadly to include civilian employment, education, and leisure. However, we (and previous researchers) actually focus on two choices—military and civilian employment. The theory should be expanded to explicitly account for college enrollment perhaps using a multinomial logit model. Labor supply studies from which to draw on are Boskin (1974) and Schmidt and Strauss (1975).

We define the net utility of enlistment as follows:

$$U^* = U_{Army}(A, J_A) - U_{Civilian}(C, J_C). \quad (3)$$

We observe enlistment if $U^* > 0$. We assume U^* is a linear function of observable supply factors, $x'\beta$, and an error term e that represents the net effect of unobservable factors. It follows that

$$U^* = x'\beta - e. \quad (4)$$

The probability of enlistment P, given x equals $P[U^* > 0 | x]$. Given Equation (4), the probability of enlistment equals $P[e < x'\beta | x]$. If $F(.)$ is the cumulative distribution function of e, the probability of enlistment is $F(x'\beta)$.[16] The cumulative distribution function $F(.)$ determines the functional form of the empirical model for estimating enlistment probability. It is a probit model if $F(.)$ is normally distributed and a logit model if $F(.)$ has a logistic distribution. This constrains P to values between 0 and 1.

2. Information and Recruiting Effort Variables

a. Recruiters and Advertising[17]

An individual chooses a job based on the available information. We expand the model to include variables that provide information on Army enlistment and alternatives. Let INF/POP be an index of available information per population. Then the probability of Army enlistment is a function of INF/POP.

Recruiters, advertising and other factors produce information. We assume a log-linear relationship between INF/POP and these factors per population:

$$INF/POP = e^{a0} [X_I/POP]^{a1}. \quad (5)$$

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16 In mathematical notation, $P[Enlist | x] = P[U^* > 0 | x] = P[e < x'\beta | x] = F(x'\beta)$.

17 Grissmer, Amey, Arms, Huck, and Imperial (1974) did the first enlistment study to include recruiters. Almost all studies since then have included recruiters; for examples see Greenston, Goldberg, Goetke, Dennis, and Andrews (1983), Daula and Smith (1985), Dertouzos (1985), Goldberg (1991), and Warner (2002). Early advertising studies include Goldberg (Jun 1982), Goldberg (Sep 1982), Greenston, Goldberg, Goetke, Dennis, and Andrews (1983), and Dertouzos, Polich, Bamezai, and Chesnutt (1989); more recent studies are Warner (1990, 1991, and 2001) and Hogan, Dali, Mackin, and Mackie (1996).

where X_I are information variables (e.g., Army recruiters and advertising). We expect *INF* to be a positive function of Army recruiters and advertising and a negative function of recruiting and advertising efforts by civilian employers and colleges.

The effect of other services' recruiters and advertising is uncertain; it might attract civilians to the Army who would not have enlisted in any service, but it might attract Army enlistees into another service. The effect may vary by service. Recruiting efforts by one service (e.g., Air Force) may increase Army enlistments, while those by another (e.g., Marine Corps) may reduce it. This is an empirical question.[18]

b. GSMA and GSFA Goals

At this point we have a generic enlistment model, but our objective is to develop models for GSMA and GSFA enlistments. We have to modify the generic model to account for the targeting of recruiting effort on GSMA and GSFA production. The recruiter is (explicitly or implicitly) assigned a contract mission for enlistment cohorts, (i.e., GSMAs, GSFAs, nongraduates, prior service, etc.). We assume recruiting effort is a postive function of the GSMA/GSFA contract mission per recruiter, and a negative function of the nonGSMA/GSFA contract mission per recruiter.[19] GSA recruiting effort also depends upon the reward for achieving each mission category.[20] We expand X_I to include these recruiting effort variables.

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18 Findings on inter-service competition are mixed (Thie and Fossett, 1999, and Warner, 2001).

19 Jehn and Shugart (1976) were the first to include goals as an explanatory variable that shifts the supply curve. Later Dertouzos (1985) included two goal variables: one for high quality and a second for other enlistments that, respectively, increase and reduce high-quality enlistments. This approach has gained wide acceptance. Daula and Smith (1985) and Berner and Daula (1993) used a switching regression model in which low goals shift production to an entirely different curve. This approach is not widely used, possibly because contract missions are usually way above production. In a U.S. Army Reserve (USAR) study with station-level data, Goldberg (1991) treated high-quality goals as endogenous (i.e., a function of supply). This may yield better estimates of supply factors by eliminating simultaneity bias. The treatment of goals is still an open question and needs further research with time-series cross-sectional (TSCS) data.

20 Unfortunately, we do not have data on recruiter incentives. For a discussion of recruiter incentives see Oken and Asch (1997).

3. Empirical Models

All enlistment supply models have been estimated with aggregate data. The earliest models were estimated with data from the draft era: cross-section (Fisher, 1969; Gray, 1970; and Grissmer, Amey, Arms, Huck, and Imperial, 1974) and time-series (Goldberg, Jun 1982; Ash, Udis, and McNown, 1984; Cook, 1970; and Fechter, 1970). Most later studies, beginning with Goldberg (Sep 1982), used time-series cross-sectional (TSCS) data from the AVF era. Researchers have been primarily concerned with measuring the effects of resources rather than forecasting. The TSCS models are useful for policy analyses but they forecast poorly and are more difficult to update.

The EEWS includes the only enlistment models estimated with time-series data solely from the AVF era.[21] In general, time-series models are useful for forecasting but coefficient estimates typically have large standard errors because of multicollinearity. The EEWS uses time-series data to maximize forecasting accuracy and to faciliate system maintenance. The estimates are plausible but, as expected, their standard errors are relatively large.

Most researchers estimate a loglinear model.[22] If E is the number of enlistments and POP is the eligible population, the enlistment model for an area is given by:

$$\ln E/POP = b_1 \ln X_A + b_2 \ln X_C + b_3 \ln X_I/POP + b_4 \ln Z + u. \tag{6}$$

where X_A is the economic benefit of Army enlistment, X_C is the economic benefit of the civilian alternative, Z is observable nonpecuniary factors, and u is unobservable factors. Nonpecuniary factors Z are usually ommited and included in the error term. As a result, the typical TSCS model in the literature is as follows:

$$\ln E/POP = b_1 \ln X_A + b_2 \ln X_C + b_3 \ln X_I/POP + u. \tag{7}$$

The logarithm of the enlistment rate is a log-linear function of explanatory variables.[23] Researchers combine military earnings (element of X_A) and civilian

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21 Two studies used time-series data that bridged the draft and AVF eras. Ash, Udis, and McNown (1984) used semi-annual data (1967–76) to estimate models for each service. Goldberg (Jun 1982) used quarterly data (1971–77) to estimate a Navy model.

22 Fisher used a semilog (1969) and Gray (1970), a linear model, but both are rare. The critical requirement is that the model must permit diminishing effects of factors on enlistments.

earnings (element of X_C) into a single variable—relative military pay. The TSCS studies typically include unemployment, recruiters, and goals. Some studies also include advertising and policy variables to adjust for changes in eligibility and recruiting effort.[24]

4. Goals and the Measurement of Enlistment Supply

Figure 6 depicts an enlistment supply curve S_0. It is a positive function of relative military pay. Holding other factors fixed, as relative military pay increases from P_0 to P_1 enlistments increase from E_0 to E_1. As other factors change, the supply curve shifts to the left or right. For example, an increase in unemployment shifts the curve to the right from S_0 to S_1. Although pay is unchanged (P_0), enlistments increase from E_0 to E_1.

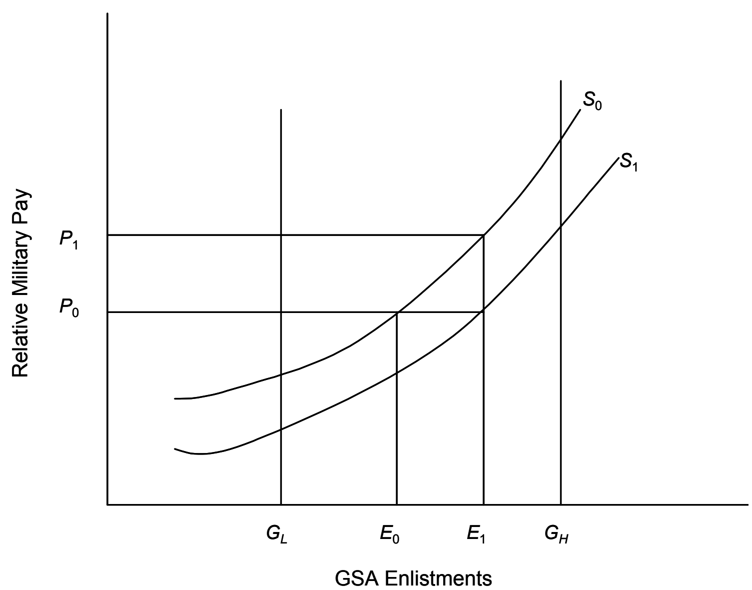

Figure 6. Enlistment Supply and Goals

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23 In the log-linear model, the enlistment rate is not constrained between 0 and 1. This could lead to poor forecasts if factors were drastically changed. However, in practice this does not seem to be a serious problem.

24 The services influence enlistment supply by changing policies affecting eligibility. To measure the effect, one could change the eligible population pool by the number who are excluded/included. However, this requires accurate data on the (mentally, medically, and morally) eligible population, which is, itself, a major research task (Goldberg and Goldberg, 1989). Researchers seldom take policy changes into account. Those that do, typically include a policy change dummy variable in the model (Goldberg, 1991).

Suppose the supply curve is S_0, relative military pay is P_0, and enlistments are E_0. If the enlistment goal were relatively high, say G_H, we would actually observe E_0 enlistments. If pay increased to P_1, we would observe E_1 enlistments and we could measure the effect of the pay raise. However, if the enlistment goal were relatively low, say G_L, we would observe G_L (approximately) rather than E_0 enlistments. Low goals prevent us from observing the supply curve and the effects of factors on it. To estimate the supply curve, we must use data from periods where goals are greater than production.

We derived an enlistment model from the theory of labor supply, modified to include information and recruiting effort. The theory provides a rationale for including relative economic benefits, recruiters, goals, advertising, demographics and policy changes. Next, we specified econometric models for Army GSMA and GSFA enlistments, and estimated them with national monthly-level data for all or part of the period FY 1981–01. To test the methodology, we estimated similar models for the other services.

B. Specification of Army Enlistment Models and Data Sources

We rewrote Equation (7), grouping the lnPOP terms on the right side, adding monthly seasonals X_S, and including moving average (MA) error terms in u (not shown):

$$\ln E = b_1 \ln X_A + b_2 \ln X_C + b_3 \ln X_I + (1 - b_3) \ln POP + b_4 X_S + u. \tag{8}$$

We estimated Equation (8) for Army GSMA and GSFA enlistments with national monthly-level data (FY 1981–01). Initially, we included population (lnPOP) as an explanatory variable. Because of measurement error and little monthly variation, population had no effect and was dropped.

Table 1 specifies the variables, except for individual months and MA terms.

Table 1. Specification of Log-linear Army Enlistment Models

Variable	Definition	Data Source/Period
GSMA	Contracts; NPS male, 1–3A, HSDGs + HSSRs	DMDC; 10/78–9/01
GSFA	Contracts; NPS female, 1–3A, HSDGs + HSSRs	DMDC; 10/92–9/01
Military Pay	$BPY_1 + BPY_2/1.3 + BPY_3/1.3^2 + BPY_4/1.3^3$, where BPY = YOS-specific expected Basic Pay @ actual Army TIG; 5-month moving average centered on current month	BPY from OUSD/ Compensation 10/78–9/01; TIG from OSD/EPM 10/78–9/99
Civilian Pay	$CPY_{18} + CPY_{19}/1.3 + CPY_{20}/1.3^2 + CPY_{21}/1.3^3$, where CPY = age-specific average annual earnings of high school graduates who work full time by gender; 5-month moving average centered on the current month	Current Population Surveys (monthly earnings files); from NBER 1/79–12/99, from CPS/BLS Web site 1/00–9/01
Relative Military Pay	Military Pay ÷ Civilian Pay by gender	Computed
Unemployment	Unemployment rate for total civilian labor force	CPS/BLS; 1/70–9/01
Recruiters	Regular Army production recruiters	USAREC; 10/78–9/01
Advertising	General and Regular Army media placement costs in thousands ÷ media cost indexes (base = 1983); weighted average over last 6 months, weights = 6/21, 5/21, …,1/21	Advertising data from USAREC, 1/80–9/01; media cost indexes from McKann-Erickson, 1/79–9/01
GSMA Goal	GSMA contract mission per recruiter: GSMA mission until FY 1994; monthly GSA mission × annual goal for NPS males per NPS accession since FY 1995	Monthly contract missions assigned to recruiters from USAREC, 10/80–9/01; NPS total and male accession goals from HQDA/DAPE-MPA, 10/94–0/01
Other Goals	Total contract—GSMA/GSFA mission, per recruiter	USAREC; 10/80–9/01
GSFA Goal	GSFA contract mission per recruiter: GSFA mission for FY 1992–94; monthly GSA mission × annual goal for NPS females per NPS accession since FY 1995	NPS female accession goals from HQDA/DAPE-MPA, 10/94–0/01
Bonus	Expected total bonus available ÷ CPI: Bonus = $\Sigma_i \Sigma_j WMOS_i \times WTOS_j \times B_{ij} \div CPI$, where $B_{ij} = AB_{ij} + EB_{ij} + HG_{ij} + QS_{ij}$ in t, $WMOS_i$ = average percent NPS accessions in MOS_i, and $WTOS_j$ = average percent NPS accessions in TOS_j	Bonuses by MOS/TOS and MOS and TOS weights from HQDA/DAPE-MPA, 10/79–9/01; CPI from BLS 10/79–9/01
ACF + MGIB	Expected maximum present value of Army education benefits available, @ 30% discount rate, ÷ annual college cost (4-year public institution); MOS/TOS weighted and deflated measure similar to the bonus variable	ACF by MOS/TOS from HQDA/DAPE-MPA, 1/79–9/01; cost of college from U.S. Department of Education, 1/78–9/01

Notes: ACF = Army College Fund; BLS = Bureau of Labor Statistics; CPI = Consumer Price Index; CPS = Current Population Survey; DMDC = Defense Manpower Data Center; EPM = Enlisted Personnel Management; HQDA/DAPE-MPA = Headquarters, Department of the Army, Office of the Deputy Chief of Staff for Personnel; HSDG = High School Degree Graduate; HSSR = High School Senior; MGIB = Montgomery GI Bill; MOS = Military Occupational Specialty; NBER = National Bureau of Economic Research; OSD = Office of the Secretary of Defense; OUSD = Office of the Under Secretary of Defense; TIG = Time in Grade; TOS = Term of Service; USAREC = U.S. Army Recruiting Command; YOS = Years Of Service.

1. GSA Contracts

From the earlier EEWS research, we had data from the Defense Manpower Data Center (DMDC) on GSA *diploma* graduates and seniors in FY 1981–89 by military service. DMDC updated the GSMA series through FY 2001, and provided data on GSFAs for FY 1993–01 by service. For the Army, DMDC contracts exclude about 10 percent with alternative credentials.[25] The EEWS adjusts the forecasts from the enlistment models to include those with other credentials based on recent trends.

2. Relative Economic Benefits

To measure relative military pay, we used the ratio of the expected present value of military earnings over a 4-year enlistment (Military Pay) to the expected present value of civilian earnings (Civilian Pay) over the same period.[26]

a. Military Pay

To calculate military pay, we used data on military earnings by pay grade and years of service (YOS) weighted by time in grade (TIG). Military earnings are measured with data on wage earnings, or Basic Pay (BP). We also considered Regular Military Compensation (RMC) for an unmarried enlistee with no dependents; it includes BP plus allowances for housing, subsistence, and their implicit tax advantage. RMC applies only for soldiers who live off base. Since enlistees live in the barracks for all or most of their first term, allowances are a small part of their compensation during the first term. Therefore, we used BP rather than RMC to measure military earnings.

Pay tables with data on BP and RMC by years of service and time in grade were obtained from OUSD/Compensation. OSD/EPM provided data on average time in grade by service in the sample period. To smooth monthly fluctuations caused by intermittent pay raises, we used a 5-month moving average centered on the current month.

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25 That is the ratio of USAREC's total "Tier 1" HSDGs plus seniors to DMDC's diploma graduates plus seniors in FY 2001. Other Tier 1 contracts vary over time due to policy changes. To obtain a consistent measure for model estimation, we excluded other Tier 1 contracts.

26 A 30-percent discount rate is used to calculate the present value of earnings and Army educational benefits for enlistees. For evidence supporting use of a relatively high discount rate for enlistees see Warner and Pleeter (2001), p. 48.

b. Civilian Pay

We assumed enlistment occurs at age 18. As a measure of civilian earnings during years 1, 2, 3, and 4 of the first term, we used data on the full-time earnings of 18-, 19-, 20-, and 21-year-old high school graduates. Data on civilian earnings by gender are from the Current Population Survey (CPS) Monthly Earnings Files. To smooth fluctuations, we used a 5-month moving average centered on the current month.

c. Relative Military Pay

Figure 7 graphs relative military pay for males using Basic Pay (labeled RBP) and the higher Regular Military Compensation (labeled RRMC) as measures of military earnings. RBP increased continuously in FY 1980–83 and then fluctuated until FY 1993. RBP declined continuously between FY 1993 and FY 2000 and then, reversing trend, increased in FY 2001 and FY 2002.[27] The historical pattern is basically the same for RRMC except for a spike in FY 1997 because of increases in housing allowances.

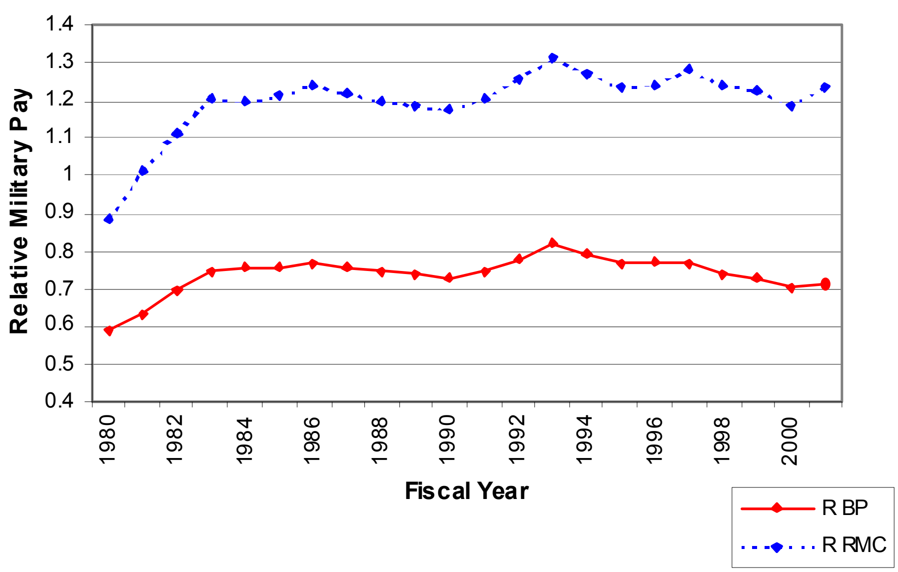

Figure 7. Trends in Relative Military Pay for Males

27 Compared to male high school graduates, Civilian Pay is about 17 percent lower for females in the 1990s. As a result, relative military pay is about 17 percent greater for females.

Figure 8 highlights the declines in relative military pay since FY 1993. From FY 1993 to FY 2000, RBP fell by 14 percent and RRMC, by 9 percent. Pay raises in FY 2001 and a slowdown of the economy have partially made up for these declines.[28]

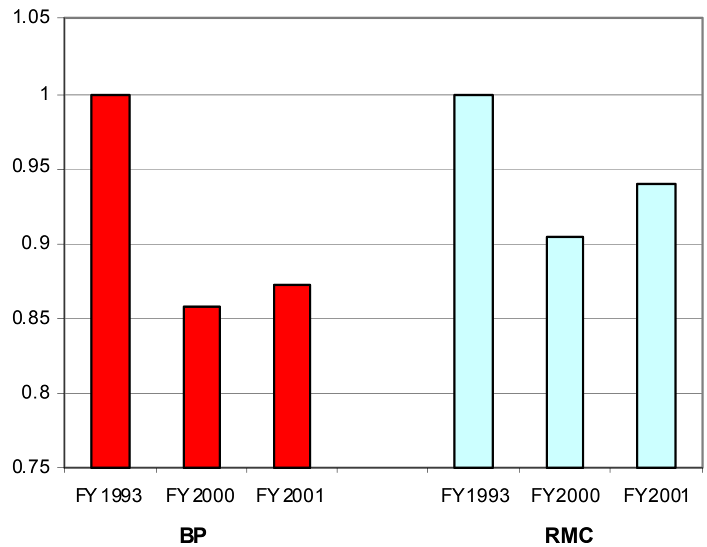

Figure 8. Relative Military Pay Declines Between FY 1993 and FY 2000–01

d. Unemployment

Figure 9 graphs unemployment in CY 1979–2001 for youth (16–19 and 16–24) and all civilian workers. Data are, again, from the CPS. All series move together over the business cycle, however the youth unemployment series are more volatile because of smaller samples. While the series are highly correlated, unemployment for all workers better explains fluctuations in enlistments.

Fluctuations in unemployment are the major cause of shifts in enlistment supply. To forecast enlistments, the EEWS forecasts the unemployment rate of all workers over the next 12 months. Multi-year forecasts of this series are available from outside sources (e.g., Blue Chip Economic Indicators). These will be used in the future to expand the forecasting horizon of the EEWS.

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28 The upward trend continued in FY 2002-03 (see Table 18).

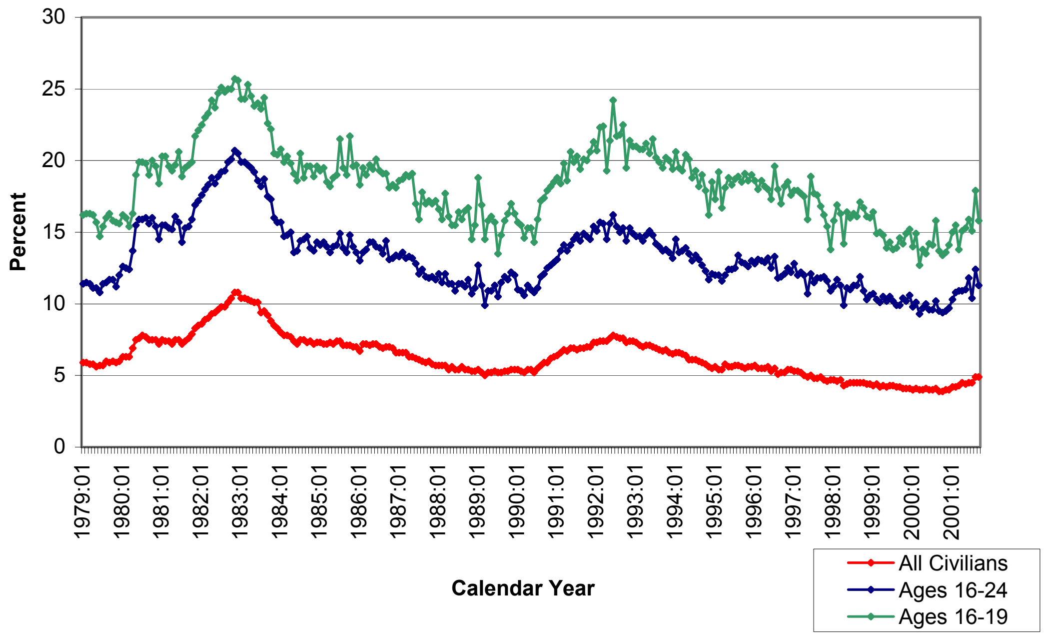

Figure 9. Trends in Unemployment

The unemployment rate for all workers fell from 7.09 in FY 1993 to 4.04 in FY 2000—a decline of 43 percent.[29] Over the same time period, relative military pay declined by 14 percent. We will show that these declines had large negative effects on enlistment supply for all the services—but especially for the Army.

e. Army Education Benefits

The Montgomery GI Bill (MGIB) is the basic military education benefits program available to all recruits. It provides payments for post-service education and job training; payments are a function of the enlistee's term of service (TOS). The Army also offers extra education benefits or "kickers" for college enrollment under the Army College Fund (ACF) program. ACF benefits are offered to GSAs in many Military Occupational Specialties (MOSs) provided that enlistment is for the required TOS or longer.

To measure Army education benefits, we created a weighted index of the expected maximum education payments *available* to recruits each month. We assume the enlistee stays for one term, and then he/she enrolls in college and collects the maximum payments allowed. The education benefits index is the

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29 Unemployment increased in FY 2001 (4.38) and again in FY 2002 (5.71). The EEWS forecast is 5.64 in FY 2003 (see Table 18).

sum of the present value of the maximum payments available each month by MOS and TOS, weighted by the average percentage of non-prior service accessions in each MOS and TOS in the sample period. The variable in the enlistment model is this index divided by the annual cost of college at a 4-year public school.

Headquarters, Department of the Army, Office of the Deputy Chief of Staff for Personnel (HQDA/DAPE-MPA) provided data on ACF benefits and bonuses by MOS and TOS.[30] They also provided data for the index weights (i.e., average non-prior service accessions by MOS and TOS in the sample period). Data on MGIB benefits by TOS are from the Veterans Administration. To create the deflator, we used data on college costs from the U.S. Department of Education, and data on the college cost component of the Consumer Price Index (CPI) from the Bureau of Labor Statistics (BLS).

Army educational benefits increased in the 1980s until 1986 and then declined until about September 1997 (Figure 10). In response to recruiting shortfalls, benefits have increased since FY 1998.

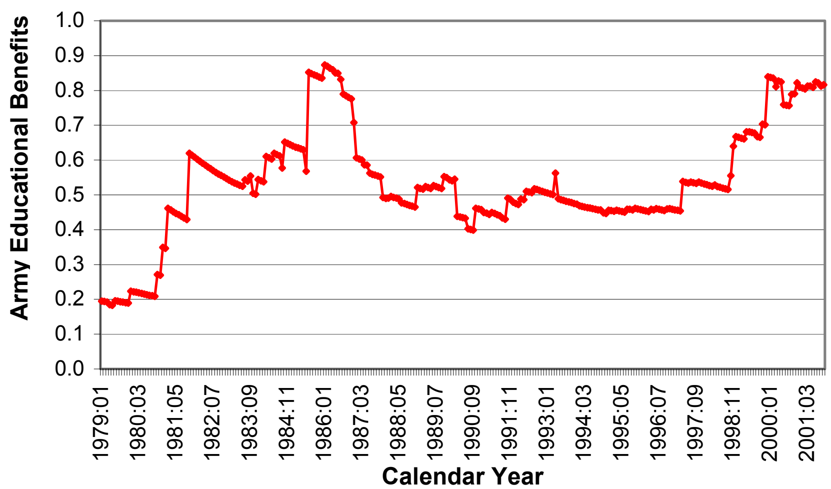

Figure 10. Trends in Army Educational Benefits

30 Data for FY 1982-01 on Army education benefits and bonuses were available in paper copies of messages HQDA sent intermittently to USAREC. From these, we used Microsoft Access to create a file of data on benefits by MOS and TOS for each program. We then used the file to calculate monthly indexes for education benefits and bonuses.

f. Bonuses

Most Army bonuses are available under the Basic Enlistment program; bonuses are also offered under the HIGRAD, Airborne, and Quick Ship programs. The Basic Enlistment and Airborne programs channel enlistees into hard-to-fill MOSs. The Basic Enlistment program is also used to increase enlistment terms. The HIGRAD program targets those with some college experience. The Quick Ship program is a bonus for immediate enlistment, and it is used to even out the flow of enlistments.

Like education benefits, we measured the bonus program each month using an index of expected benefits adjusted for inflation. The bonus index is the sum of total bonuses *available* by MOS and TOS, weighted by the average percentage of non-prior service accessions in each MOS and TOS in the sample period. We deflated the expected bonus index by the CPI to construct the Army bonus variable in the enlistment model (Figure 11). As noted, data on bonuses were obtained from HQDA/DCSPER. The CPI data used to deflate the bonus index are from BLS.

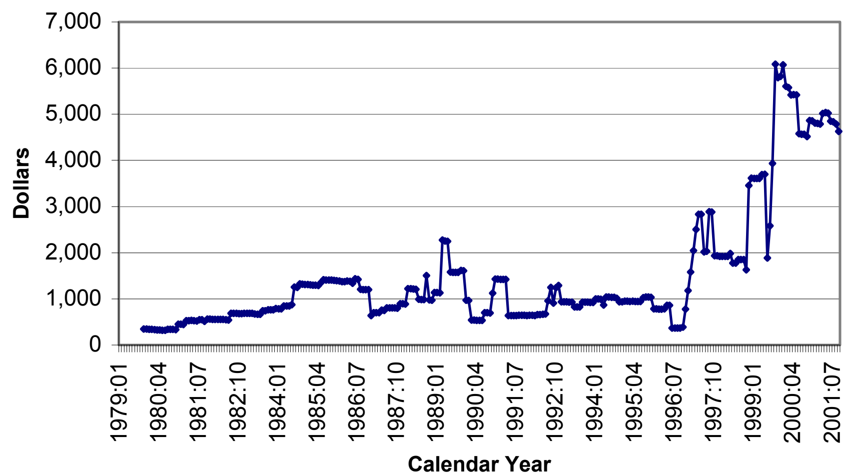

Figure 11. Trends in Army Bonuses

Bonuses increased in the 1980s until 1987 and then fluctuated until 1997. To help prevent shortfalls, bonuses have been rising since 1997. While the trend is up, there is a lot of month-to-month variation because Quick Ship bonuses fluctuate during the year.

3. Information and Recruiting Effort

a. Recruiters

We measure recruiters with data on Regular Army production recruiters (Figure 12). Data were provided by USAREC for FY 1979–01.

Recruiters increased throughout the 1980s until 1989. Because of the draw down, the Army reduced the recruiting force in FY 1990–93. Faced with contract shortfalls, the Army continued to add recruiters in most years after FY 1993.

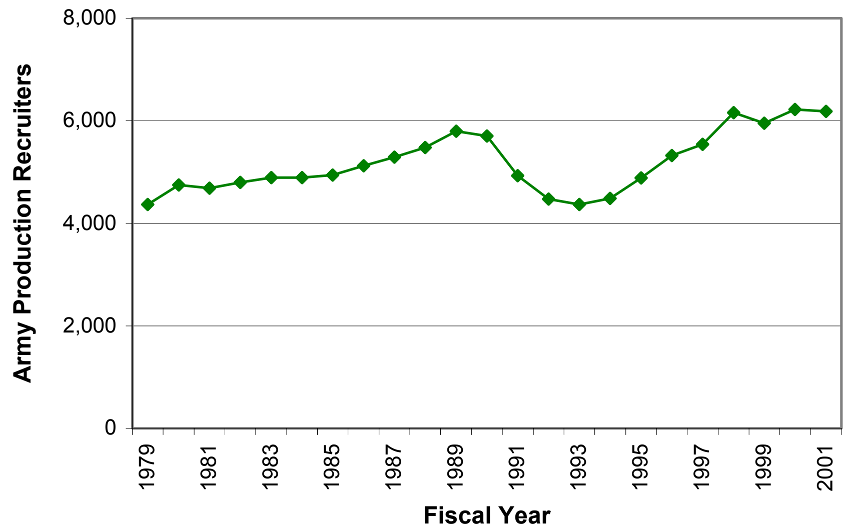

Figure 12. Trends in Army Recruiters

b. Contract Missions Assigned to Recruiters

Figure 13 graphs contract missions assigned to recruiters for Total, GSMA, and non-GSMA contracts; Figure 14 graphs analogous figures for GSFAs.[31] USAREC assigned GSA missions by gender until FY 1994. After FY 1994, we used the percent of NPS accessions goal accounted for by NPS males (from HQDA/DAPE-MPA) to distribute GSA contract missions by gender.

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[31] The GSA mission assigned to recruiters is larger than USAREC's minimum GSA contracts requirement depicted in Figure 3. USAREC assigned a higher mission to recruiters to maximize their efforts and to provide more contracts than are minimally required.

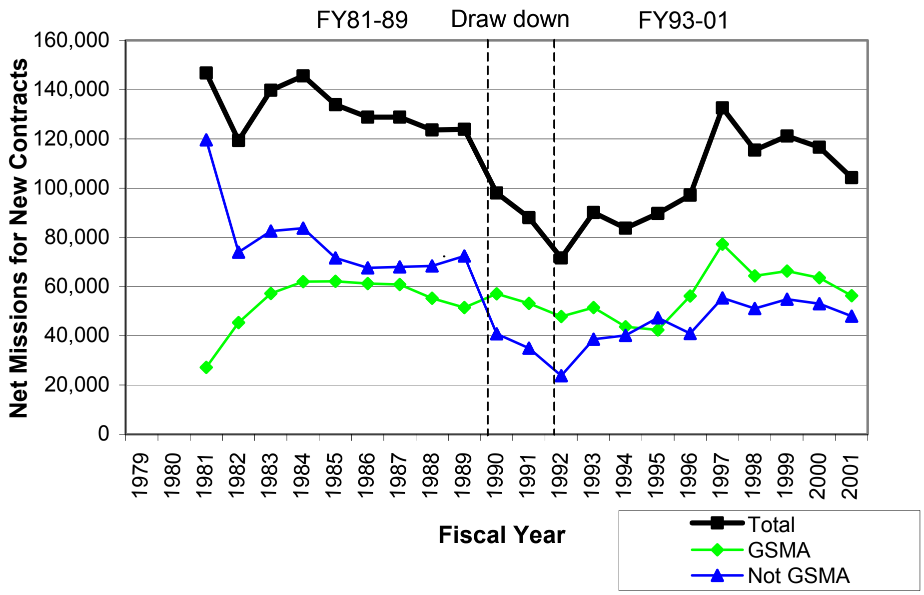

Figure 13. Total and GSMA Contract Missions Assigned to Recruiters

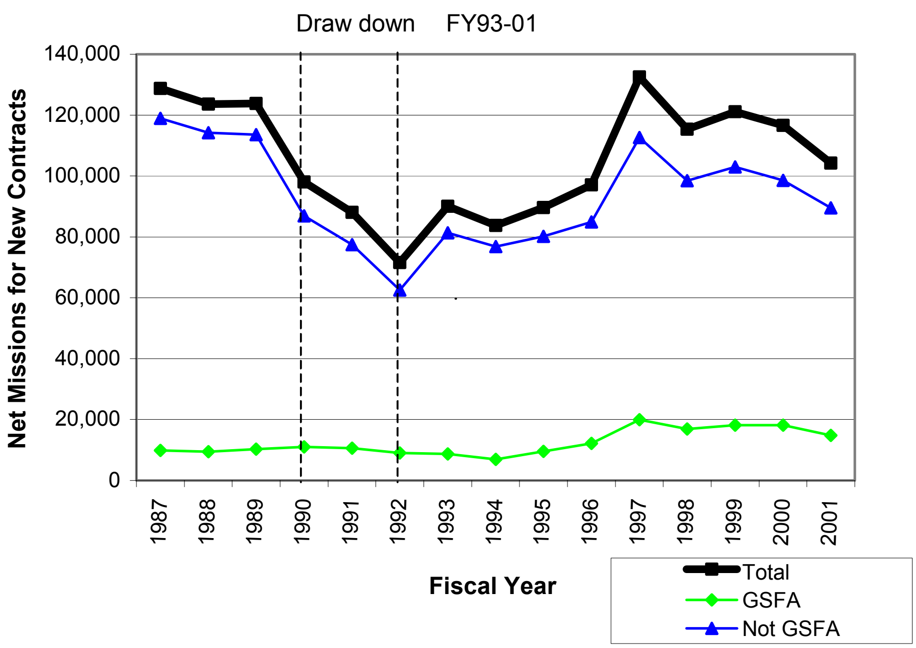

Figure 14. Total and GSFA Contract Missions Assigned to Recruiters

Total contract missions declined gradually from FY 1984 to FY 1989, and because of the draw down, they declined sharply in FY 1989–92. The total contract mission increased in FY 1995–97 and has tended to decline since then. The GSMA mission mirrors changes in the total contract mission. Unlike GSMAs, the GSFA contract mission has been relatively constant since FY 1997.

c. Army Advertising

Previous enlistment studies typically assume that advertising has a declining effect over time (Dertouzos, Polich, Bemezai, and Chesnutt, 1989; Goldberg, Jun 1982; Hogan, Dali, Mackin, and Mackie, 1996; and Warner, 2001). We assumed advertising affects enlistments over a 6-month period.[32] Our variable is a declining weighted average of advertising in the last 6 months.[33] Advertising each month for the General and Regular Army Program is measured with data on media placement costs in 1983 dollars for TV, radio, and print. We adjusted placement costs in the current year for inflation since 1983 using media cost indexes from the McKann-Erickson advertising agency.

Data on media placement costs are from USAREC. Monthly data were available for 1/80–12/89 from the original EEWS. After 1989, only quarterly data were available. To estimate advertising costs in the 1990s, we distributed quarterly expenses using the monthly pattern that prevailed in the 1980s. This introduces measurement error and may explain why we found no effect of advertising on Army GSMAs in the 1990s.

Figure 15 shows that Army advertising fluctuates a great deal within each year. Annually, advertising was fairly constant in the 1980s. It declined in 1990 to 1993 due to the draw down. Advertising has been increasing since 1994 in response to recruiting difficulties.

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32 For evidence, see Dertouzos, Polich, Bamezai, and Chesnutt (1989).

33 Weights are 6/21, 5/21,..., 1/21.

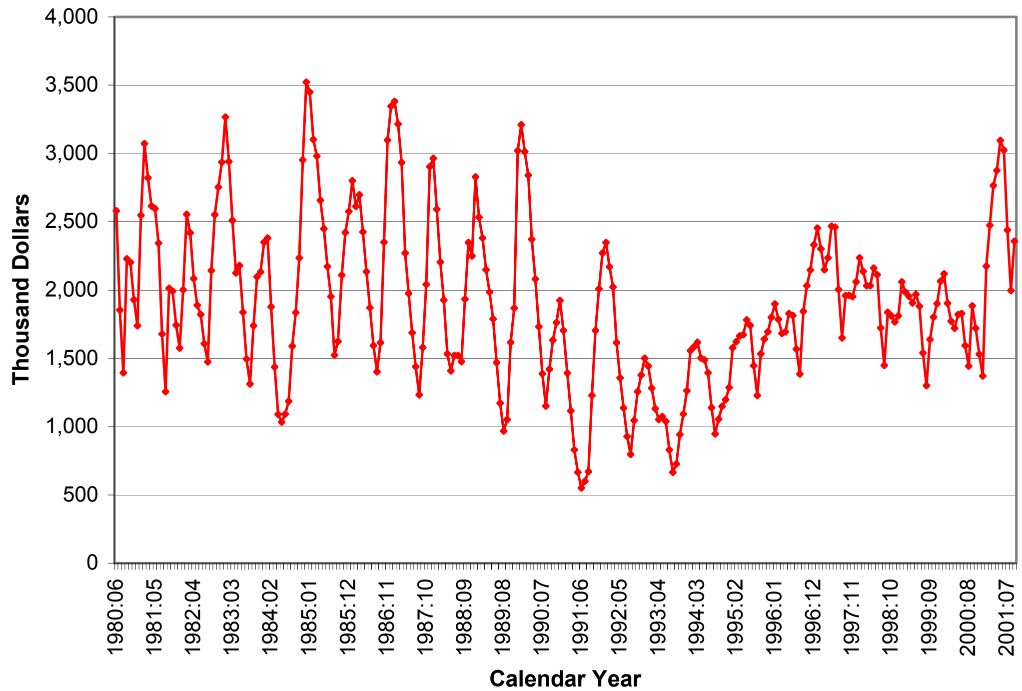

Figure 15. Trends in Advertising

d. Youth Population

We constructed the following two monthly measures of youth population: (1) 17– to 21–year-old civilian, non-veteran, non-institutionalized high school graduates and seniors; and (2) the same measure minus full-time college enrollees and those with 2 or more years of college completed.[34] Separate measures were constructed for males and females. We obtained data on the youth population from the monthly CPS surveys for 12/79–9/01. Because the series varied considerably in the summer months because of the school year, we interpolated observations between May and October and smoothed the series using a 12-month moving average.

The CPS provides monthly snapshots of annual data. As a result, we have slowly changing series that drift down in the 1980s and up in the 1990s (e.g., see Figure 16 for trends in male population). We included these "monthly"

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34 These series measure the number of "military availables." An alternative approach would have been to construct a "qualified military available" (QMA) series that accounts for the mental, medical, and moral requirements for enlistment, but this was beyond the scope of the study. For an example of how to construct a QMA series, see Goldberg and Goldberg (1989).

population variables in the models. Not surprisingly, they did not explain monthly variations in enlistments and, therefore, were dropped. [35]

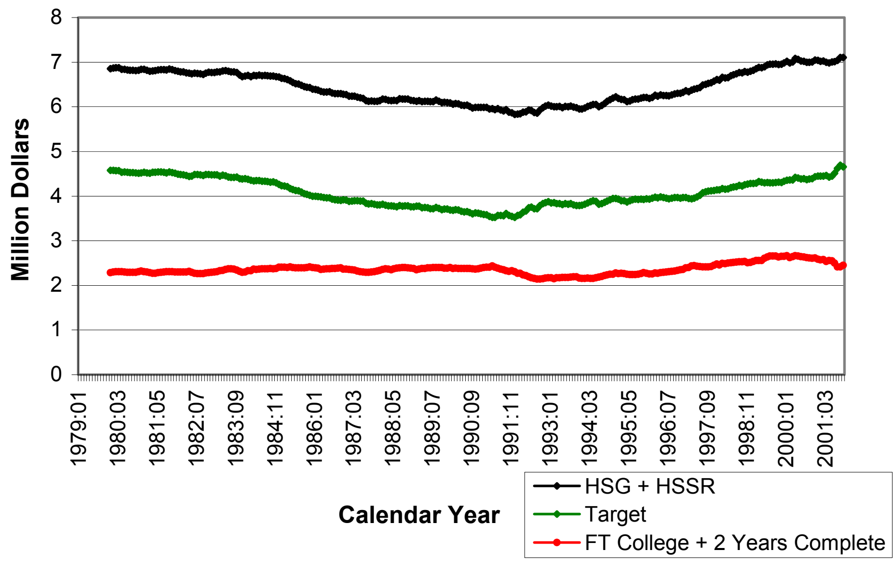

Figure 16. Trends in Male Youth Population Series

e. Recruiting Shortfalls in the 1990s: A Summary

An economic boom throughout FY 1993–00 brought about large declines in unemployment and relative military pay. After the draw down ended in FY 1995, there were large increases in GSA contract missions. Declines in supply and increases in demand caused contract shortfalls to emerge and worsen in FY 1993–01. In response, the Army incrementally added advertising and recruiters starting in FY 1994, bonuses starting in FY 1997, and ACF benefits starting in FY 1998. Unfortunately, the Army's gradual response was too little and too late to prevent accession shortfalls in FY 1998 and FY 1999.

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35 It appears that monthly time-series data are not suitable for measuring the effects of population because the series change too slowly. More research is needed—with time-series cross-sectional data—to measure the effects on enlistments of changes in the QMA population and college enrollment.

C. Estimates of the Army Enlistment Models

1. Estimation Methodology

We estimated time-series regression models for GSMA and GSFA enlistments with national monthly level data. For greater forecasting accuracy, the models included moving average error terms. This type of time-series regression model with explanatory variables is called a "transfer function."[36] From the original EEWS research, we had data by service on GSMA enlistments and supply factors for FY 1981–89. We updated the GSMA database to include observations for FY 1981–2001 and constructed a GSFA database for FY 1993–2001. Compared to the original EEWS, we substantially refined measures of relative military pay, Army education benefits, and Army bonuses. We used these data to estimate Army GSMA and GSFA models. To test the sensitivity of the results to other data sets, we also estimated GSMA and GSFA models for the other services with data through 3/01.[37]

2. GSMA Model

We initially estimated Army GSMA models with monthly data for FY 1981–CY 2000. The model under-predicts enlistments in the 1980s and over-predicts them in the 1990s. To analyze these errors, we estimated a "1980s model" with data for just FY 1981–89 and used it to forecast enlistments in FY 1990–CY 2000. The 1980s model, accurate until FY 1989, over-predicts enlistments after FY 1989 (Figure 17). The error averages about 20 percent in FY 1990–92 and 40 percent thereafter.

Because of low goals compared to supply in FY 1990–92, data from this period were not useful for estimating enlistment curves. We dropped the data for FY 1990–92 and re-estimated a "pooled model" with a dummy variable for the 1990s (FY93–00). Table 2 reports the findings (minus dummy variables for months and moving average terms). The estimate of the FY93–00 dummy variable indicates that GSMA enlistments declined, for some unknown reason, by 42 percent in FY 1993–CY 2000 compared to FY 1981–89.

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36 For a discussion on how to estimate transfer functions see Pindyck and Rubinfeld (1981), pp. 593–595.

37 Models were estimated using Regression Analysis for Time Series (RATS) software, Version 4.

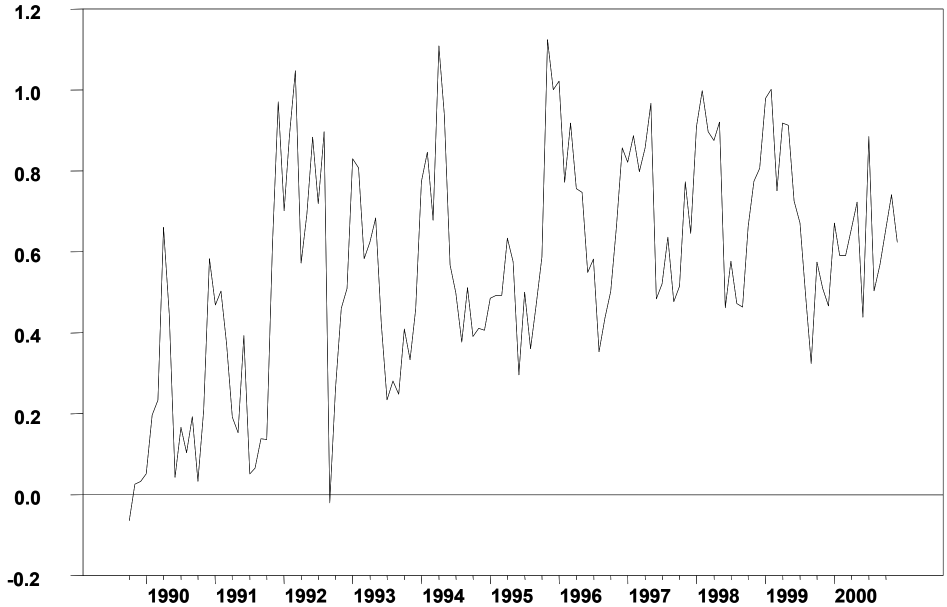

Figure 17. Out-of-Sample Forecasting Errors: (Forecast – Actual)/Actual

Table 2. Army GSMA Models Estimated with Data from the 1980s, 1990s, and Both

	1980s Model FY 1981–89		1990s Model 10/92–12/00		Pooled Model FY 1981–89; 10/92–12/00	
Variable	Coefficient	*t*-value	Coefficient	*t*-value	Coefficient	*t*-value
Constant	1.610	0.55	2.291	1.16	3.154	1.74
Relative Military Pay	0.745	2.04	0.721	2.57	0.869	3.36
Unemployment	0.479	4.45	0.645	3.79	0.478	4.72
GSMA Goal	0.303	5.64	0.136	2.86	0.202	4.37
Other Goals	–0.233	4.11	–0.053	0.93	–0.141	3.06
Recruiters	0.667	2.06	0.533	2.61	0.473	2.34
ACF + MGIB	0.103	1.42	0.125	1.37	0.165	2.71
Bonus	—	—	0.038	1.43	—	—
Advertising	0.065	1.60	—	—	0.085	1.91
Dummy FY 1993–00	—	—	—	—	–0.420	9.74
ρ	—	—	—	—	0.562	8.57
Adjusted R^2	0.923		0.871		0.932	
SEE	0.064		0.058		0.080	
Durbin-Watson	2.095		1.979		2.124	
# Observations	108		99		207	
Error Structure	MA 1, 2, 3		MA 1, 8, 10		Auto-regressive (1)	

Note: Monthly seasonal dummies not shown.

The unexplained drop in enlistments is known as a "regime change." Other researchers have estimated enlistment supply models with time-series cross-sectional data that span the draw down period. They also find a regime change in the 1990s (Warner, 2001, and Hogan, Dali, Mackin, and Mackie, 1996).

A symptom of a regime change is unstable coefficient estimates. We also estimated a model with just 1990s data (see Table 2). A comparison of this model with the 1980s model indicates that variables have similar effects qualitatively, but the constant term and many of the coefficients are different.

The puzzling regime change that begins in FY 1990 needs to be studied.[38] However, there is a silver lining in this cloud—the phenomenon is stable after FY 1992. Our approach is to use data from the stable period starting in FY 1993 to build GSMA and GSFA models for the EEWS—and to be on the alert for further regime changes.

a. Identifying and Addressing Regime Changes

When the Economic Research Laboratory (ERL) ran the EEWS in the 1980s, it found *temporary* regime changes caused by policy shifts almost every year. ERL developed procedures for identifying and correcting for regime changes. Basically the problem is an omitted variable. The solution is to add a variable measuring the omitted factor.

ERL found that a regime change causes coefficient estimates to vary as data are added. Table 3 reports three estimates of the Army GSMA model obtained with slightly different samples. For each sample, the first observation is 10/92; the last observations are 12/00 (Model 1), 3/01 (Model 2), and 9/01 (Model 3). The table includes estimates for monthly dummies and MA terms as well as the primary explanatory variables. Since the coefficient estimates are similar in the three models, there is no evidence of a regime change in FY 2001.

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38 There are numerous potential causes of the regime change. Given the timing and pattern of the over predictions, we suspect it was at least partially due to the draw down (e.g., closing of recruiting stations and perhaps policy changes affecting eligibility). Non-pecuniary factors may have played a role: the end of the Cold War in FY 1989 may have reduced interest in military service; reductions in force and increases in operating tempo may have soured influencers. Warner (2001) provides evidence that an increase in college attendance is one reason for enlistment declines in the 1990s. While this is perhaps a long-run determinant, it does not explain the sudden over-predictions in Figure 17.

Table 3. Estimates of Army GSMA Models for the EEWS

	Model 1 10/92–12/00		Model 2 10/92–3/01		Model 3 10/92–9/01	
Variable	Coefficient	*t*-value	Coefficient	*t*-value	Coefficient	*t*-value
Constant	2.290	1.16	1.930	1.04	2.182	1.22
Relative Military Pay	0.721	2.57	0.698	2.52	0.740	2.82
Unemployment	0.645	3.79	0.673	4.29	0.648	4.30
GSMA Goal	0.136	2.86	0.129	2.77	0.130	2.96
Other Goals	–0.052	0.93	–0.048	0.88	–0.037	0.68
Recruiters	0.532	2.61	0.570	2.95	0.546	2.92
Bonus	0.037	1.43	0.034	1.33	0.039	1.52
ACF + MGIB	0.125	1.37	0.138	1.60	0.124	1.58
June	0.408	11.98	0.406	12.11	0.412	12.38
July	0.333	8.17	0.333	8.32	0.331	8.34
August	0.418	10.06	0.422	10.35	0.406	10.09
September	0.263	6.53	0.258	6.54	0.252	6.49
October	0.217	6.18	0.214	6.19	0.212	6.18
November	0.126	3.41	0.122	3.39	0.116	3.21
December	0.128	3.24	0.120	3.14	0.118	3.09
January	0.187	4.77	0.194	5.14	0.190	5.02
February	0.127	3.28	0.138	3.68	0.126	3.36
March	0.189	6.19	0.192	6.45	0.183	6.21
Moving Avg. 1	0.497	4.28	0.487	4.35	0.448	4.35
Moving Avg. 8	–0.614	4.85	–0.611	5.03	–0.621	5.09
Moving Avg. 10	–0.717	5.15	–0.710	5.27	–0.757	6.25
Adjusted R^2	0.870		0.869		0.861	
SEE	0.058		0.058		0.060	
Durbin-Watson	1.979		1.942		2.148	
# Observations	99		102		108	

ERL also used 6-month out-of-sample forecasts to identify regime changes. A regime change occurs if forecasting errors are beyond the 95 percent confidence interval of the forecast.[39] We re-estimated Model 3 with data through FY 2000 and forecasted FY 2001, given actual values of explanatory variables.

39 If a regime change occurred, ERL would identify the cause through conversations with the service. Invariably, the Recruiting Command made a policy change that was not in the model (e.g., change in enlistment standards). Sometimes it was possible to construct a historical series and include the omitted variable in the model. Usually it was a temporary effect that was accounted for with a dummy variable.

Out-of-sample errors in FY 2001 are random and relatively small—again, no evidence of a regime change.

b. General Statistics

To facilitate comparisons with the other services, we focused on the GSMA model (Model 2) estimated with 1990s data through 3/01 (Table 3). The model fits the data well: the Standard Error of the Estimate (SEE) is low—0.058; the adjusted R^2 is 0.87 percent, indicating that the model explains most of the variation in enlistments. With MA terms (1, 8, and 10), there is no evidence of autocorrelation based on the Durbin-Watson statistics.

c. Coefficient Estimates

A common problem in time-series studies is collinearity among explanatory variables. It results in large standard errors, so variables may not be statistically significant. In the 1990s, unemployment and military pay declined more or less continuously, and resources (recruiters, advertising, bonuses and education benefits) all tended to increase, especially after FY 1997.

Despite collinearity, relative military pay and unemployment have strong and statistically significant effects on enlistments: "elasticities" are 0.70 for pay and 0.67 for unemployment.[40] Recruiters have a large statistically significant effect: the recruiter elasticity is 0.57. As expected, GSMA goals per recruiter increase enlistments (0.129) and non-GSMA goals per recruiter reduce them (-0.048), although the latter effect is not significant.

Collinearity is a measurement problem for the other variables. Army education benefits have a moderate effect (0.14) but it is not statistically significant.[41] The effect of bonuses is small (0.034) and not significant.[42] Bonuses may also have a small effect because the primary goal of the program is to channel enlistees into hard-to-fill MOSs rather than to increase enlistments.[43]

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[40] "Elasticity" is the percentage change in the dependent variable (GSMAs) for each one percent increase in the independent variable (e.g., unemployment). In a log-linear model, the coefficients are elasticities.

[41] Previous studies usually find a moderate effect of Army education benefits (Warner, 2001; Fernandez,1982; and Smith, Hogan, and Goldberg, 1990.

[42] Previous studies usually find a small effect of bonuses on the number of enlistments (Warner, 2001; Smith, Hogan, and Goldberg, 1990; and Polich, Dertouzos, and Press, 1986).

Advertising had no effect on Army GSMAs in the 1990s due to collinearity and other factors.

One additional factor is measurement error. We found an effect of advertising on GSMAs in the 1980s (elasticity .065 Table 2) but not in the 1990s. We had monthly data for the 1980s, but only quarterly observations for the 1990s. We had to construct monthly observations for the 1990s, but this introduced measurement error that biased the effect toward zero.

A National Academy of Science study offers another explanation (Sackett and Mavor, eds., 2002, p. 227). It notes that despite a 318 percent increase in all military advertising, *enlistment propensity* did not increase from 1993 to 2000. The study speculates that military advertising was service-specific and had no effect because of inter-service competition.[44]

3. GSFA Model

Table 4 reports three GSFA models also estimated with data starting in 10/92 and ending at 12/00, 3/01, and 9/01. The GSFA model is less stable than the GSMA model: some coefficients change as the sample increases. Forecasting tests indicate that the GSFA model over predicts contracts in the second half of FY 2001.

We focused on the model estimated with data through 3/01 to facilitate comparisons with other cohorts. The GSFA model fit the data well; however, compared to Army GSMAs, the SEE is higher (0.070) and the adjusted R^2 is lower (0.77). With moving average terms (1, 2, 3, and 10), there was no evidence of autocorrelation based on the Durbin-Watson statistics.

Relative military pay and unemployment have strong and statistically significant effects on enlistments: the elasticities are 0.80 for pay and 0.48 for unemployment. Recruiters also have a large statistically significant effect—0.61.

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43 Another reason it has a small effect may be "simultaneity bias." The bonus program expanded in the 1990s when supply declined. This causes the estimate to be biased toward zero. The estimates of recruiters, advertising, and education benefits may also be biased for the same reason.

44 For GSMAs, we found an effect of advertising in the 1980s (elasticity .065, from Table 2) but not in the 1990s. We had monthly advertising data for the 1980s but only quarterly data for the 1990s. To create monthly observations, we interpolated the 1990s quarterly data using the monthly expenditure rates in the 1980s. This introduced measurement error that may explain the insignificance of advertising for GSMAs in the 1990s.

Table 4 Estimates of Army GSFA Models for the EEWS

	Model 1 10/92–12/00		Model 2 10/92–3/01		Model 3 10/92–9/01	
Variable	Coefficient	*t*-value	Coefficient	*t*-value	Coefficient	*t*-value
Constant	–0.957	0.41	-0.581	0.25	1.076	0.47
Relative Military Pay	0.889	2.45	0.798	2.21	1.097	3.25
Unemployment	0.532	2.91	0.481	2.63	0.327	1.87
GSFA Goal	0.084	3.36	0.087	3.53	0.087	3.60
Recruiters	0.613	2.43	0.610	2.38	0.454	1.81
Advertising	0.226	3.04	0.195	2.84	0.191	2.94
May	–0.066	2.39	–0.061	2.23	–0.061	2.28
June	0.160	4.91	0.164	4.99	0.162	5.06
July	0.225	6.43	0.223	6.37	0.229	6.94
August	0.319	7.77	0.312	7.73	0.304	7.94
September	0.184	5.55	0.183	5.53	0.164	5.04
October	0.079	3.05	0.074	2.87	0.072	2.77
March	0.097	4.15	0.094	4.22	0.094	4.29
Moving Avg. 1	0.445	4.17	0.450	4.32	0.442	4.36
Moving Avg. 2	0.235	1.98	0.242	2.08	0.234	2.04
Moving Avg. 3	0.278	2.51	0.310	2.89	0.308	2.94
Moving Avg. 10	-0.189	1.82	–0.193	1.87	-0.228	2.41
Adjusted R^2	0.777		0.772		0.764	
SEE	0.070		0.070		0.071	
Durbin-Watson	1.935		1.907		1.858	
# Observations	99		102		108	

Unlike GSMAs, advertising seems to have a strong effect on GSFAs (0.19 elasticity). The effect of GSFA goals per recruiter is significant but relatively low (0.087). GSFA goals and Army advertising both trend upwards in the 1990s. We suspect that advertising's relatively large effect may be due to its correlation with GSFA goals.

We find no effects of education benefits and bonuses with variables specifically constructed for GSFAs. Perhaps this is because the programs are targeted more or less on hard-to-fill MOSs and many of these are closed to women.

4. Effects of the Economic Boom in the 1990s and Sensitivity Analyses

The economic expansion in the 1990s had a strong adverse effect on Army GSAs through declines in relative military pay and unemployment. Between FY

1993 and FY 2000 unemployment declined by 43 percent and relative pay declined by about 14 percent. These changes caused Army GSMAs to decline by 38.7%, and Army GSFAs to decline by 25.7% (Table 5).

Table 5. Effects on GSAs of Declines in Unemployment and Relative Military Pay in the 1990s

Service	Effect on GSMAs	Effect on GSFAs
Army	–38.7%	–25.7%
Navy	–27.5%	–30.7%
Air Force	–17.3%	–32.5%
Marine Corps	–11.4%	–29.2%

To test the sensitivity of the methodology to alternative data sets, we estimated enlistment models for the other services with data from the 1990s through 3/01 (Appendixes C–E). The results were similar: relative pay, unemployment, and recruiting resources strongly affect their enlistments. Likewise, the 1990s economic boom had large negative effects on their GSA contracts. For example, Navy GSMAs declined by 27.5 percent; Navy GSFAs by 30.7 percent (Table 5). However, given parameter estimates and the gender mix of enlistments, the service most adversely affected by the economic boom was the Army.

D. Validation Tests

We conducted out-of-sample forecasting validation tests for the enlistment models. For all services, our approach was as follows: (1) estimate GSMA and GSFA models with data through 3/00; (2) forecast enlistments monthly in 4/00–3/01; and (3) calculate the aggregate percent error for total GSAs in the forecast period. Validation Test 1 uses actual values for all explanatory variables in the forecast period. Validation Test 2 uses EEWS forecasts of unemployment and relative pay and actual values of the other variables (e.g., recruiters and goals). We also tested the forecasting accuracy of the Army models in FY 2001.

1. Validation Tests in 4/00–3/01 for All Services

Annual forecasting errors are small (Table 6). In Validation Test 1, the error ranges from 0.17% for the Marine Corps to –1.59% for the Army. Using EEWS forecasts of unemployment and civilian pay, the error doubles (on average) but it is still quite small.

Table 6. Out-of-Sample Forecasting Validation Tests in 4/00–3/01

Service	Validation Test 1 (Actual Values of Unemployment and Earnings)	Validation Test 2 (Forecasts of Unemployment and Earnings)
Army	–1.59%	–3.05%
Navy	–1.25%	–1.91%
Air Force	–1.20%	–2.83%
Marine Corps	0.17%	–0.71%

2. Additional Tests for the Army Models in FY 2001

For the Army models, we collected more data and conducted additional forecasted tests in FY 2001. Given actual values of the explanatory variables, the error in FY 2001 was just 0.8%. However, with forecasted values of unemployment and pay, the error (under-prediction) was –7.39 percent in FY 2001 (Table 7).

Table 7. Validation Test 2 in FY 2001 for the Army GSA Models

Group	Forecast	Actual	Error	% Error
GSMA	31,442	34,864	–3,422	–9.82%
GSFA	10,007	9,891	116	1.17%
GSA	41,449	44,755	–3,306	–7.39%

This under-prediction of enlistments occurred because the EEWS under-predicted unemployment—the error was –9.0 percent (Figure 18). The EEWS did not predict the "dot com meltdown." However, with 4 more months of data, the unemployment forecasts improved dramatically: the error in 2/01–9/01 declined to –2.2 percent. As a result, the enlistment forecast error in 2/01–0/01 also declined to less than –2.0 percent.

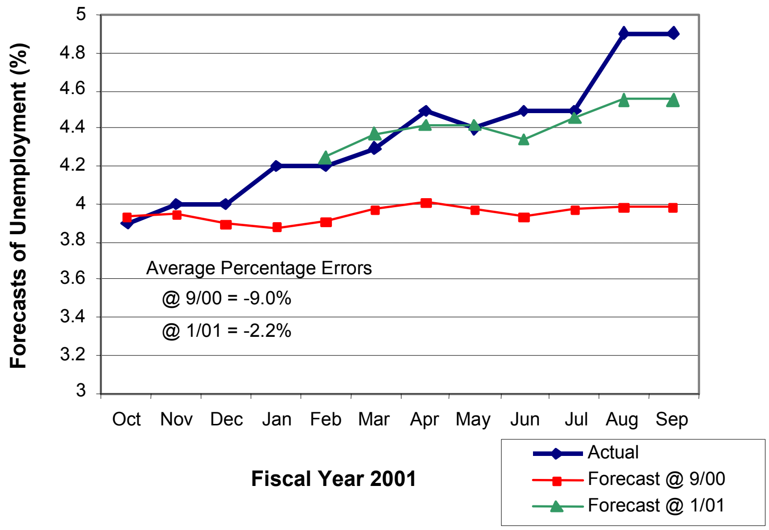

Figure 18. Forecasts of Unemployment in FY 2001

E. Recruiting Risk Analysis

1. Simulation Methodology

The original EEWS forecasted the expected number of contracts over the next 12 months and compared it with the mission. We enhanced the original EEWS by generating a probability distribution for next year's production of "gross" contracts (i.e., production without adjustment for losses due to DEP attrition).

The probability distribution of contracts was estimated using computer simulation. The simulation methodology takes into account (1) the uncertainty of the regression model and its parameter estimates, (2) the uncertainty of unemployment forecasts, and (3) correlations between residuals in the GSMA and GSFA models

The first step was to randomly generate 50,000 forecasts of unemployment for each month in the forecast period. We assumed unemployment forecasts have a normal distribution, with a mean equal to the unemployment forecast, and a standard deviation equal to the forecasting error of the unemployment model. Next we generated forecasts of relative military pay using the civilian earnings model, unemployment, forecasts of the CPI (e.g., from Blue Chip Economic Indicators), and planned levels of military pay.

We assumed a multivariate normal distribution for the parameter estimates in the GSMA and GSFA models and used the regression coefficients and

variance covariance matrices to estimate them. To take into account correlations between the GSMA and GSFA models, we used the covariance matrix of the residuals.

For each month in the forecast period, we generated 50,000 forecasts of GSMA and GSFA contracts given simulated unemployment, relative military pay, parameter estimates, and so on. Since the enlistment models are logarithmic, we exponentiated the forecasts and adjusted them for upward bias based on the SEEs of the regression models. Monthly forecasts were aggregated over the next 12 months and adjusted upward to include other Tier 1 contracts.

We estimate an empirical cumulative distribution function (CDF) for GSMA, GSFA, and GSA contracts based on a sort of the 50,000 annual forecasts.[45] The expression [1 – CDF] is used to calculate the probability of achieving the GSA contracts mission.

Figure 19 graphs a typical risk analysis curve [1 – CDF] for GSA contracts obtained using simulations. It measures the probability of achieving GSA contracts in FY 2002. Production ranges from 48,000 to 63,000 GSA contracts. The probability is greater than 99 percent that GSA contracts will be more than 48,000, and less than 1 percent that they will exceed 63,000.

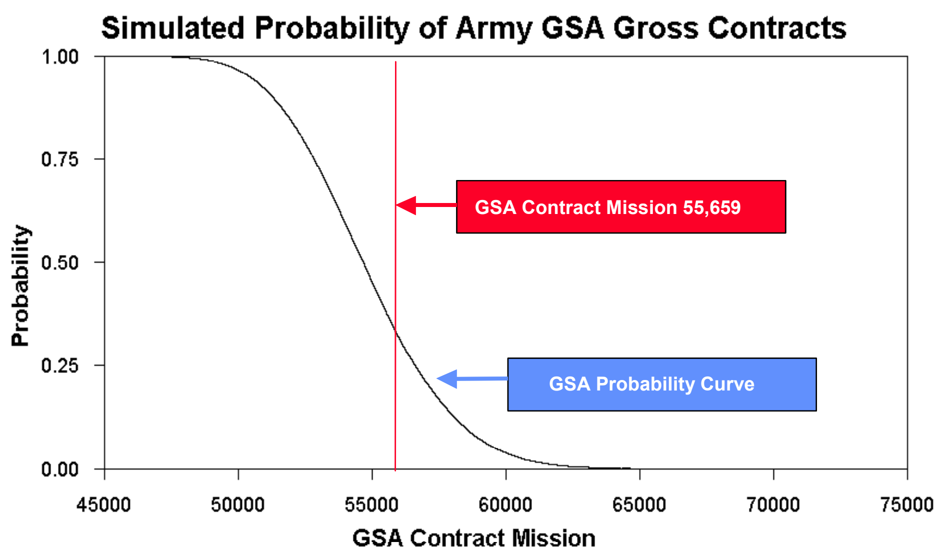

Figure 19. Risk of GSA Contract Shortfalls in FY 2002

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45 CDF = $F(x)=P[\text{forecast} \leq x]$.

2. Risk Analysis of Army Recruiting in FY 2002 and FY 2003

In FY 2002, USAREC required at least 55,659 GSA contracts to achieve its 1–3A HSDG accession goal, and end the year with 35 percent of next year's 1–3A HSDG accessions in the DEP. In October 2001, we analyzed the risk of achieving 55,659 GSA contracts in FY 2002 based on models estimated with data through September 2001: the probability of achieving the GSA mission was 28 percent.

Unemployment was 5.0 percent in September 2001. It then began to increase rapidly, and by December 2001 unemployment was 5.8 percent. With data through December 2001, the EEWS estimated the probability of making the GSA Mission in FY 2002 to be about 52 percent; in April, the probability was greater than 95 percent.

With data through September 2002, the EEWS forecasts the probability of making the GSA mission in FY 2003 to be greater than 99 percent. Table 8 reports EEWS forecasts for FY 2003 and trends in supply factors. The forecast of GSA contracts is 60,587; the mission is only 46,436. Production will be 30 percent more than the mission. Production exceeded mission by 8 percent in FY 2002. In FY 2003 the Army is planning small drops in recruiters and bonuses, but it intends to increase education benefits and advertising. The most recent recruiting crisis is now over and resources should be reduced.

Table 8. EEWS Forecasts of GSA Contracts and Supply Factors in FY 2003

Variables	Actual 10/00–9/01	Actual 10/01–9/02	Forecasted 10/0–9/03	% Change 10/02–9/03
GSA Contracts				
GSMA	38,538	47,783	48,389	1.3
GSFA	10,927	12,145	12,198	0.4
GSA	49,465	59,928	60,587	1.1
USAREC GSA Mission				
GSMA	53,565	43,414	36,220	–16.6
GSFA	14,042	12,245	10,216	–16.6
GSA	67,607	55,659	46,436	–16.6
Supply Factors				
Relative Military Pay for Males	0.71	0.77	0.78	1.0
Relative Military Pay for Females	0.83	0.89	0.90	1.1
Unemployment Rate	4.38	5.71	5.64	–1.3
Recruiters	6,184	6,407	6,232	–2.7
(ACF + MGIB)/College Cost Bonuses	0.81	0.82	0.84	2.6
(EB + HG + AB)/CPI	31.42	28.38	27.72	–2.3
Advertising/Cost Indexes	2,375	2,728	2,988	9.5
Recruiter's GSA Mission/Recruiter				
GSMA	9.1	7.1	6.6	–7.0
GSFA	2.4	2.0	1.9	–7.0
GSA	11.5	9.1	8.5	–7.0

IV. Summary, Conclusions, and Recommendations

A. Summary

The Army adds recruiting resources too slowly during economic expansions and over-budgets during recessions. This leads to accession crises and waste. To help the Army prevent accession shortfalls and better manage recruiting, this study updated and refined an EEWS that was constructed in the 1980s. The EEWS uses time-series models (transfer functions) to forecast Army GSAs. The enlistment models are estimated with national monthly-level data for the period FY 1993–01. Army enlistments are well explained by the economy and recruiting resources. To test the sensitivity of the methodology, we also estimated models for the other services. The findings are similar.

Each month the EEWS accurately forecasts enlistments (and the risk of enlistment contract shortfalls) over the next 12 months. Validation tests indicate annual errors of 1 percent to 3 percent for the Army and the other services. To maximize forecasting accuracy, the system is updated every month. The EEWS reports are available 25 days after the end of a month.

B. Conclusions

The economy strongly affects enlistment supply for all the services, especially the Army. To deal with fluctuations in supply, the Army needs timely and accurate forecasts of enlistments. The EEWS provides such forecasts.

Besides forecasting, the EEWS has proven useful to the Army in other ways. In FY 2002, the Army used it to help manage recruiting incentive programs, and to estimate the effects on enlistments of the economy, policy changes, and the September 11th terrorist attacks.

The findings are useful for policy analyses. The effects on GSA production of relative pay, recruiters, Army education benefits, and bonuses are plausible and consistent with previous findings. The effects of Army advertising on GSMAs could not be measured with 1990s data. However, a reasonable estimate was obtained with 1980s data. For advertising, we would use this estimate and estimates from other studies.

After the Cold War ended, manpower research and systems development were sharply curtailed. Systems like the EEWS were discarded and recruiting research programs were slashed or eliminated. Recruiting is a critical multi-billion dollar function that requires continuous technical support—even when goals are achieved. Only then will the Army have the information needed for cost-effectively management.

C. Recommendations

Given an EEWS "alert," the Army should make a policy response—but what? More research is needed on the effects of policies. Our estimates based on analysis of time-series data are plausible, but confidence intervals are large due to collinearity. We recommend analyzing time-series cross-sectional data to obtain more accurate estimates.

From a policy perspective, perhaps the biggest deficiency in previous studies is the analytical framework: minimize cost subject to constraints on the quantity and quality of accessions. While the Army needs to make end strength and accession quality marks, it also needs soldiers in the right MOSs. The analytical framework should be "minimize costs subject to accession *and* MOS mix constraints." This requires measuring the effect of bonuses and other recruiting resources on the MOS distribution.

The EEWS forecasts enlistment contracts over the next 12 months. The EEWS should be expanded to include multi-year forecasts and modules for budgeting and policy analyses.

A "regime change" dramatically reduced Army enlistment supply by 42 percent in the 1990s. What caused this? Can it be reversed? Will it happen again? These questions remain to be answered.

Sustained declines in relative military pay and unemployment have caused recruiting and retention crises. To prevent another crisis, we recommend indexing the growth of military pay to the growth of civilian pay and adjusting recruiting resources to changes in unemployment.

The Army should not wait for an enlistment shortfall to detect a recruiting problem; it is then too late. The Army has a timely, accurate, and credible EEWS. We recommend the Army use the EEWS to help prevent accession crises during economic expansions and save recruiting resources when the economy is in a recession.

Appendix A:
Unemployment Forecasting Model

To forecast enlistments, it is necessary to forecast unemployment. This appendix presents the unemployment-forecasting model and validation tests.

Model Specification

We estimated an Auto-Regressive Integrated Moving Average (ARIMA) model with explanatory variables. The dependent variable is the unemployment rate for the total civilian labor force, data are from the Current Population Survey (CPS)/Bureau of Labor Statistics (BLS) surveys for 1/70–9/01. The explanatory variables are 15 Leading Economic Indicators (LEI) *lagged* 12 months (Table A-1). The LEI data are U.S. government statistics now published by The Conference Board. LEI data are for 5/72–9/01. Other variables in the model are moving average error terms and lagged unemployment.

Table A-1. Leading Economic Indicators in the Unemployment Model

Variable	Definition	Code[a]
IND1	Average weekly hours, manufacturing	A0M001
IND5	Average weekly initial claims, unemployment insurance	A0M005
IND7	Manufacturers' new orders, durable goods industries	A0M007
IND8	Manufacturers' new orders, consumer goods and materials	A0M008
IND19	Index of 500 stock prices	U0M019
IND20	Contracts and orders for plant and equipment	A0M020
IND21	Average weekly overtime hours, manufacturing.	A0M021
IND27	Manufacturers' new orders, non-defense capital goods	A0M027
IND28	New private housing units started	A0M028
IND46	Index of help-wanted advertising in newspapers	A0M046
IND74	Industrial production, non-durable manufacturers	A0M074
IND75	Industrial production, consumer goods	A0M075
IND92	Manufacturers' unfilled orders, durable goods industries	A1M092
IND106	Money supply M2	A0M106
IND910	Composite index of 10 leading indicators	G0M910

[a] Conference Board variable.

Estimate of the Unemployment Model

Table A-2 presents a typical unemployment-forecasting model. It was estimated with data for 5/72–1/01 using the non-linear least square estimation technique. The model includes 15 LEI, a lagged dependent variable, and two MA terms. The R^2 is high—0.986. Due to collinearity, many of the variables are not significant, but this is not a concern since we are interested only in forecasting.

Table A-2. Unemployment Model

Variable	Coefficient	*t*-value
Constant	0.035	0.55
Unemployment {1}	0.993	100.77
IND1 {12}	6.682	2.22
IND5 {12}	–0.055	0.17
IND7 {12}	–2.665	2.69
IND8 {12}	2.200	1.93
IND19 {12}	0.029	0.11
IND20 {12}	–0.373	0.90
IND21 {12}	–1.188	2.42
IND27 {12}	0.483	1.03
IND28 {12}	–0.730	3.76
IND46 {12}	0.841	1.73
IND74 {12}	1.627	0.68
IND75 {12}	–0.408	0.18
IND92 {12}	3.046	1.88
IND106 {12}	–1.143	0.32
IND910 {12}	–1.616	0.43
MA 2	0.216	3.77
MA 4	0.194	3.40
Adjusted R^2	0.986	
SEE	0.171	
Durbin-Watson	1.973	
# Observations	345	
Sample Period	5/72–1/01	

Validation Tests

The model was estimated with data through March 2000 and then used to forecast unemployment in April 2000–March 2001 (Figure A-1). The forecasts are accurate: the average error per month was just –1.6%. During the test period,

unemployment was relatively constant. As noted in the main text, we repeated the test in FY 2001 when unemployment increased dramatically from 3.9 to 4.9 percent (see Figure 18 in the main text). The average percent error per month for all of FY 2001 was –9.0%. However, with 4 more months of data the average error for February to September 2001 was –2.2%. The model did not predict the "dot com meltdown." But with more data it "learned" quickly and adjusted the forecasts upward. We expect the model to forecast accurately enough for an EEWS. To maximize forecasting accuracy, it should be updated each month.

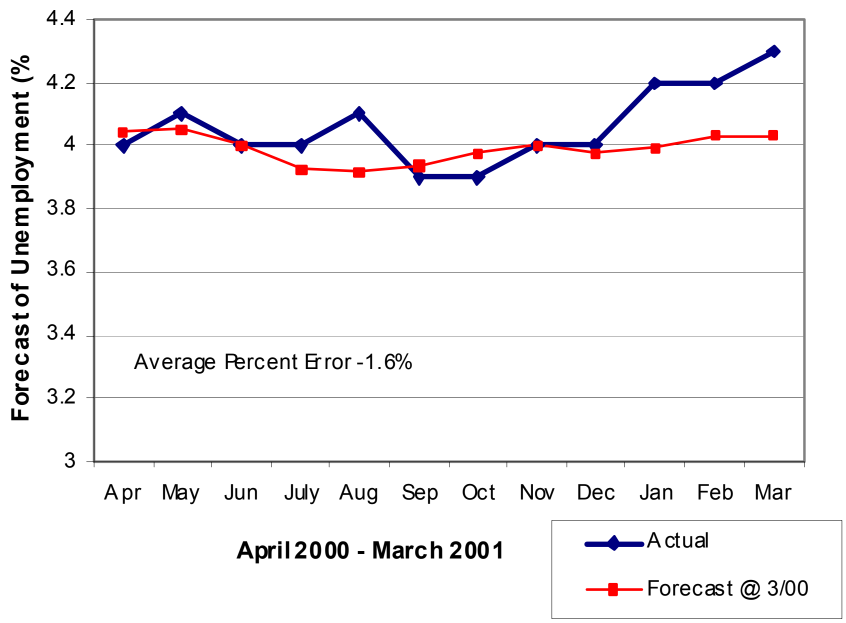

Figure A-1. Unemployment Model Validation Test

Appendix B:
Civilian Earnings Model

Introduction

To forecast enlistments, we must forecast relative military pay, which requires that we forecast civilian pay. Appendix B presents the EEWS civilian pay forecasting models.

We defined civilian pay as the present value of civilian earnings of an 18-year-old high school graduate over the next 4 years. It is measured with data on the civilian earnings of high school graduates who are 18, 19, 20 and 21 years old who work at least 35 hours per week:

$$\text{Civilian Pay} = CPY_{18} + CPY_{19}/1.3 + CPY_{20}/1.3^2 + CPY_{21}/1.3^3,$$

where CPY = average annual earnings of high school graduates by age and gender.

To reduce random monthly variations, we smoothed the civilian pay series by using a 5-month moving average. For greater accuracy, we calculated separate civilian pay series for males and females (Figure B-1). We found that while pay is greater for males, trends in the series are similar.

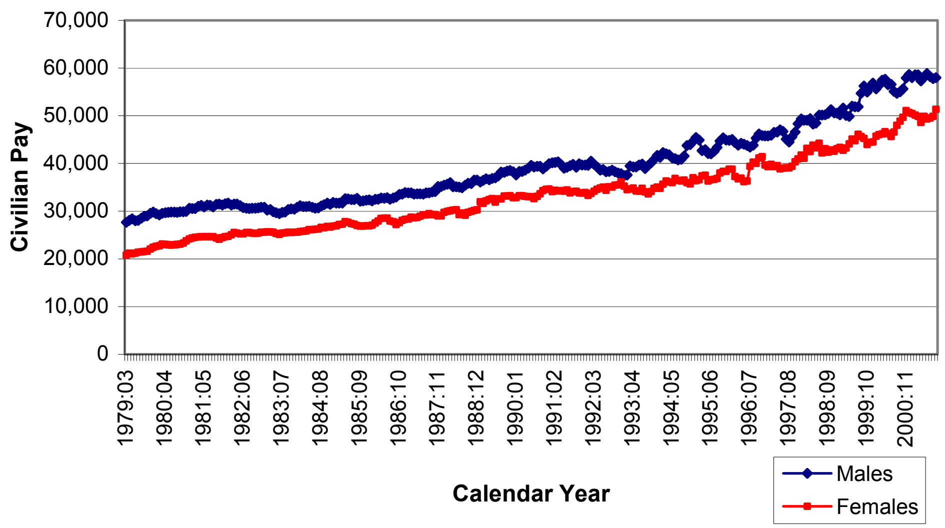

Figure B-1. Trends in Civilian Pay

Figure B-2 presents annual growth rates in civilian pay by gender. Growth rates are similar if not always equal.

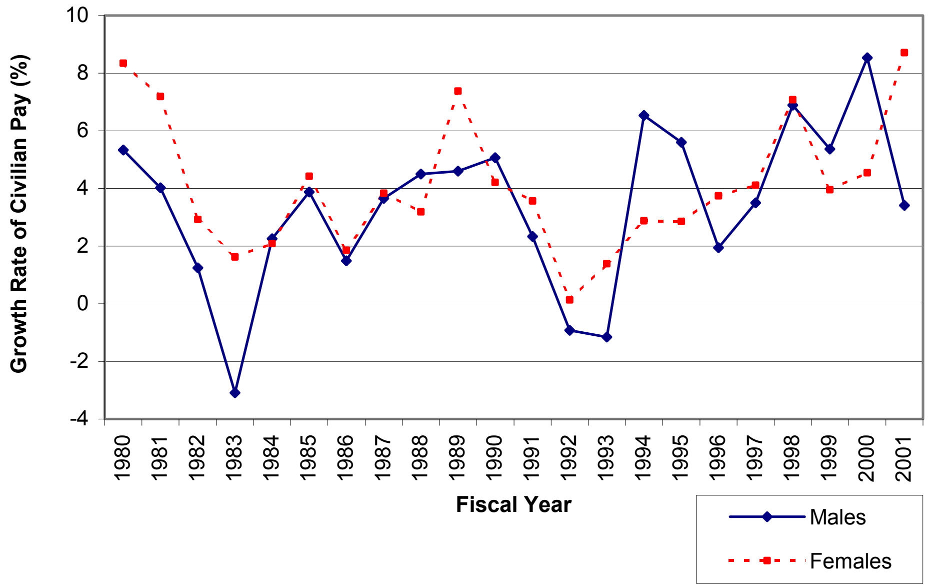

Figure B-2. Civilian Pay Growth Rates

Model Specification

The dependent variable is the year-to-year growth rate of civilian pay in the current month. The independent variables are unemployment and inflation, measured by the annualized growth rate of the Consumer Price Index (CPI). We expect wage growth to be positively related to inflation and negatively related to unemployment. The civilian pay growth rate models are used to predict relative military pay by gender over the next 12 months.

Figure B-3 graphs the growth rate of civilian pay for males and unemployment. Note that as unemployment rose in FY 1983, the growth rate of Civilian Pay fell; the reverse is true in FY 2000.

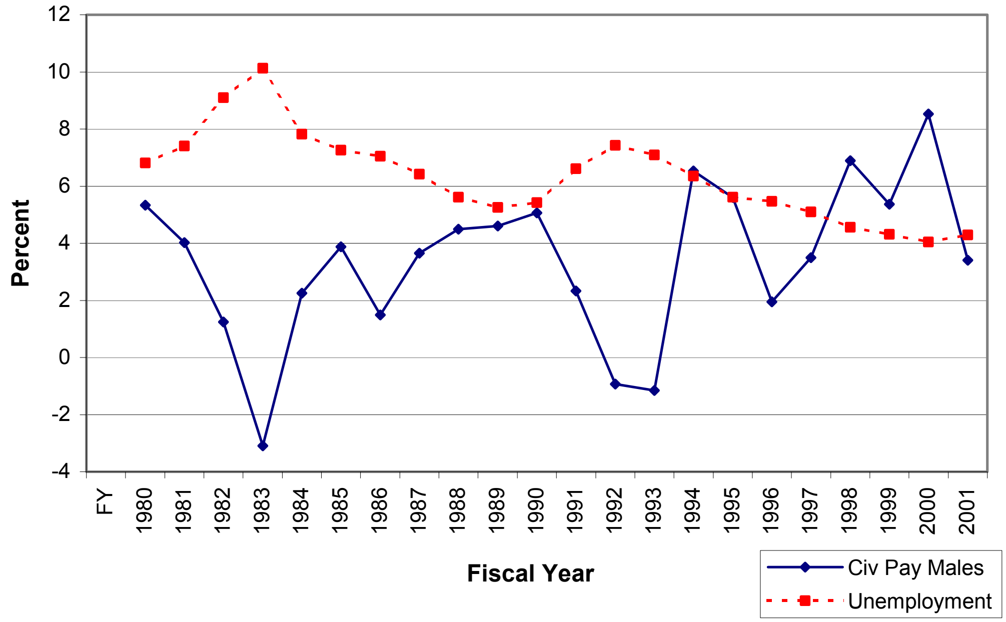

Figure B-3. Unemployment and the Growth Rate of Civilian Pay for Males

Estimates of the Model

Table B-1 reports typical civilian pay growth rate models estimated with data for 3/80–7/01. As expected, the CPI has a positive effect and unemployment a negative effect on the growth of civilian pay. Both variables are statistically significant. The models also include three statistically significant moving average (MA) terms. The models fit the data reasonably well. For males, the R^2 is 0.775, and for females, it is 0.720.

Table B-1. Civilian Pay Models

	Males		Females	
Variable	Coefficient	*t*-value	Coefficient	*t*-value
Constant	0.106	11.09	0.074	7.71
CPI Growth	0.353	6.24	0.629	8.26
Unemployment	–0.013	9.10	–0.009	6.14
MA 1	1.053	19.43	0.932	15.96
MA 2	0.482	10.69	0.437	9.13
MA 5	–0.337	11.47	–0.364	10.26
Adjusted R^2	0.776		0.720	
SEE	0.017		0.018	
Durbin-Watson	1.763		1.710	
# Observations	257		257	
Sample Period	3/80–7/01		3/80–7/01	

Validation Tests

Validation tests were undertaken in April 2000–March 2001. We re-estimated the models with data through March 2000 and then forecasted relative military pay in April 2000–March 2001 (Figures B-4 and B-5). Forecast errors tend to cancel so that the average error over the year was –0.8% for males and –1.0% for females. The test was repeated in FY 2001. Because of errors in the forecasts of unemployment, the average error for relative military pay increased to –4.2 % for males and 1.7% for females. With more data, however, the forecasting errors for unemployment and relative military pay declined quickly. We expect the relative military pay forecasts to be accurate enough for an EEWS. To maximize forecasting accuracy, they should be updated each month.

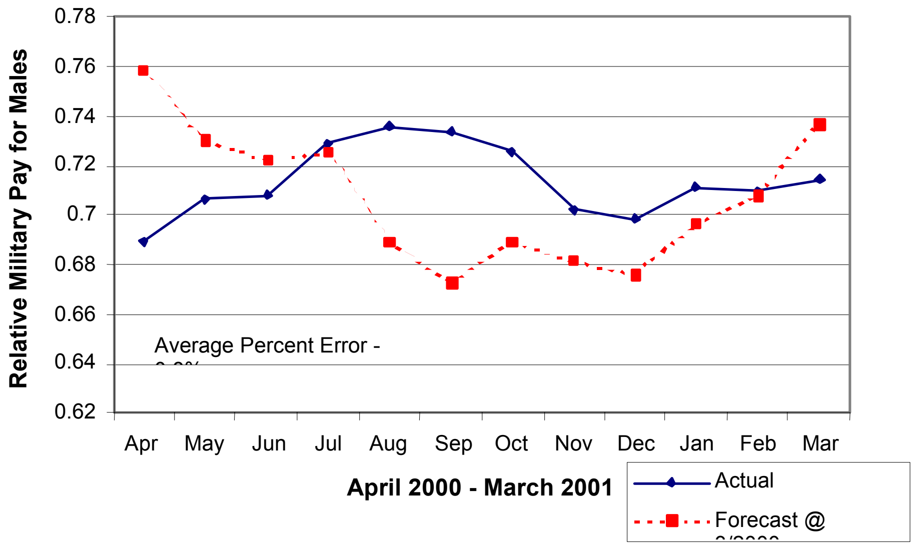

Figure B-4. Validation Test: Relative Military Pay for Males

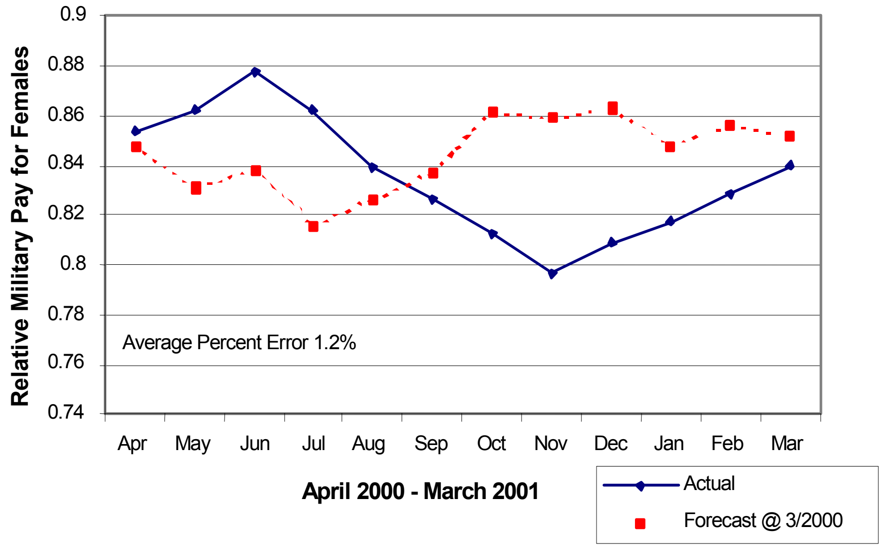

Figure B-5. Validation Test: Relative Military Pay for Females

Appendix C: Navy EEWS and GSA Forecasting Models

Navy EEWS

We also constructed preliminary Enlistment Early Warning Systems for the other military services. Figure C-1 is a flowchart describing the Navy EEWS. It includes a Navy Module with GSMA and GSFA forecasting models for gross contracts and an Economy Module.

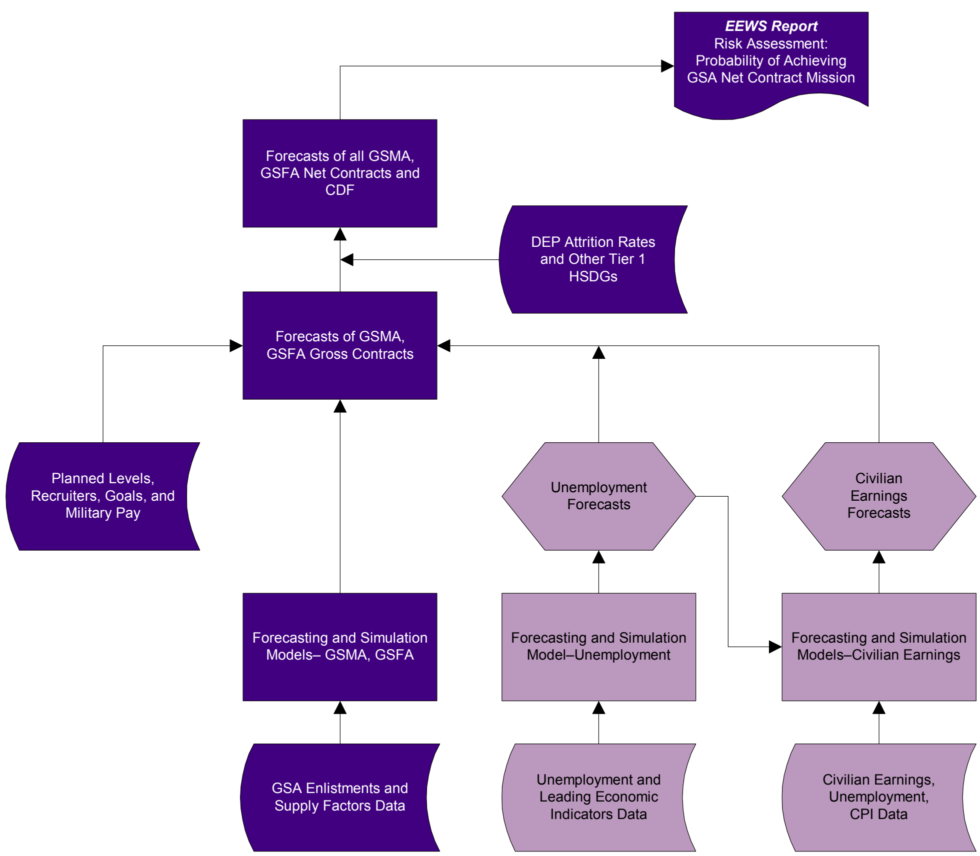

Figure C-1. Navy Enlistment Early Warning System

Unlike the Army, the other services assign a contract mission that is net of delayed entry pool (DEP) attrition. For the other services, the EEWS adjusts the gross contracts forecast for DEP attrition based on recent trends. This yields a

forecast of net contracts. The recruiting risk analysis compares the cumulative distribution function (CDF) for net contracts with the net contract mission. The Navy EEWS risk assessment report includes this analysis.

Navy GSMA and GSFA Models

The Navy models are specified in Table C-1. The explanatory variables include relative military pay, unemployment, recruiters, goals, dummies for outliers (which we believe occurred because of policy changes), dummies for months, and moving average (MA) terms.

Table C-2 reports estimates of GSMA models with data from the 1980s (Model 1), 1990s (Model 2), and both periods (Model 3). We included a dummy variable for the 1990s (FY 92) to test for a regime change. We found a regime change of –0.273, which is large but smaller than the Army's (–0.42).

We used the 1980s model to forecast FY 1990–FY 2000 and observed a pattern of over predictions like the Army's—rising errors until FY 1992 but constant after that (Figure C-2).

Given the pattern of forecasting errors, we felt justified in using the data starting in FY 1993 to estimate GSA models for the Navy. These models, estimated with data through 3/01, are given in Table C-3.

Table C-1. Specification of Navy Models

Variable	Definition	Data Source/Period
GSMA	Gross contracts; NPS male, 1-3A, HSDGs + HSSRs	DMDC; 10/79–3/01
GSFA	Gross contracts; NPS female, 1-3A, HSDGs + HSSRs	DMDC; 10/92–3/01
Military Pay	$BPY_1 + BPY_2/1.3 + BPY_3/1.3^2 + BPY_4/1.3^3$, where BPY = expected basic pay @ actual TIG Navy; 5-month moving average centered on the current month	BPY from OUSD/ Compensation 1/70–3/01; TIG from OSD/EPM 10/71–9/99
Civilian Pay	$CPY_{18} + CPY_{19}/1.3 + CPY_{20}/1.3^2 + CPY_{21}/1.3^3$ where CPY = average annual earnings of high school graduates who work full time (by gender); 5-month moving average centered on the current month	Current Population Surveys (monthly earnings files); from NBER 1/79–12/99, from BLS Web site 1/00–3/01
Relative Military Pay	Military Pay ÷ Civilian Pay	Computed
Unemployment	Unemployment rate for total civilian labor force	CPS/BLS; 1/70–3/01
Recruiters	Production recruiters	NRC; 10/81–3/01
GSMA Goal	Total net contract goal (monthly) × percent male accessions goal (FY) × percent NPS HSDG 1–3A accessions goal (FY) ÷ production recruiters	NRC; 10/81–3/01
Other Goals	Total net contract goal – GSMA (GSFA) goal, per recruiter	NRC; 10/81–3/01
GSFA Goal	Total net contract goal (monthly) × percent female accessions goal (FY) × percent NPS HSDG 1–3A accessions goal (FY) ÷ production recruiters	NRC; 10/84–3/01
D7_9 93	Categorical variable equal to 1 in 7–9/93; 0 otherwise; outlier	Computed
FY92	Categorical variables equal to 1 starting in 10/91; 0 otherwise	Computed
Monthly Dummies	Categorical variables equal to 1 in a month; 0 otherwise	Computed
MA *t*	Moving average error term variables, lag = *t*	Computed

Notes: BLS = Bureau of Labor Statistics; CPS = Current Population Survey; DMDC = Defense Manpower Data Center; EPM = Enlisted Personnel Management; HSDG = High School Degree Graduate; HSSR = High School Senior; NBER = National Bureau of Economic Research; NPS = Non-Prior Service; NRC = Navy Recruiting Command; OSD = Office of the Secretary of Defense; OUSD = Office of the Under Secretary of Defense; TIG = Time In Grade.

Table C-2. Estimates of Navy GSMA Models

	Model 1 (10/81–9/89)		Model 2 (10/92–3/01)		Model 3 (10/81–3/01)	
Variable	Coefficient	*t*-value	Coefficient	t-value	Coefficient	*t*-value
Constant	–3.968	3.87	0.905	0.81	–2.212	2.76
Relative Military Pay	0.477	1.94	—	—	0.645	2.92
Unemployment	0.726	14.22	0.642	9.66	0.729	14.20
GSMA Goal	0.480	7.23	0.4401	3.34	0.336	7.12
Other Goals	—	—	–0.156	1.90	—	—
Recruiters	1.351	11.44	0.708	5.15	1.132	12.08
FY92	—	—	—	—	–0.273	10.11
Bonus	—	—	0.038	1.43	—	—
Adjusted R^2	0.897		0.883		0.938	
SEE	0.055		0.059		0.726	
Durbin-Watson	1.974		1.745		1.880	
# Observations	96		102		234	
Error Structure	MA 1, 8, 10, 22		MA 2, 3, 16		MA 1, 2, 3, 10	

Note: Dummy variables for policy changes and seasonality are not reported.

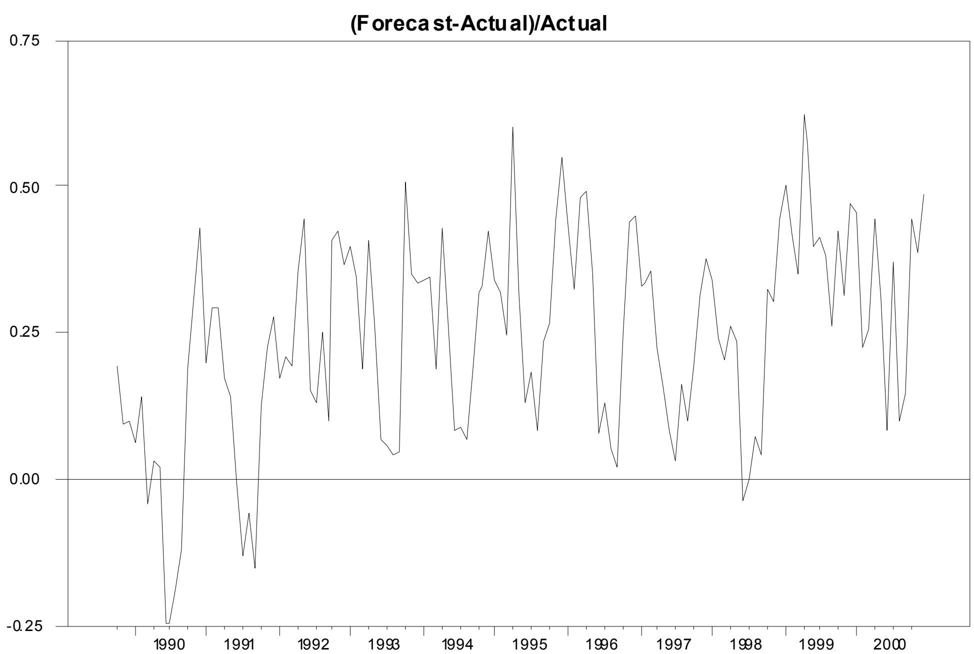

Figure C-2. Model 1 Out-of-Sample Forecasting Errors (%)

Table C-3. Navy GSMA and GSFA Models

Variable	GSMA Coefficient	GSMA *t*-value	GSFA Coefficient	GSFA *t*-value
Constant	0.905	0.81	–0.575	0.29
Relative Military Pay	—	—	0.592	1.32
Unemployment	0.641	9.66	0.623	4.41
GSMA Goal	0.440	3.34	—	—
GSFA Goal	—	—	0.415	6.11
Other Goals	–0.155	1.90	—	—
Recruiters	0.707	5.15	0.827	3.55
D7_9 93	—	—	–0.380	6.59
May	–0.077	2.82	—	—
June	0.249	9.52	0.144	5.42
July	0.214	8.16	0.155	4.99
August	0.233	8.26	0.154	5.03
September	0.106	3.91	—	—
December	—	—	-0.070	2.60
January	0.088	3.85	—	—
February	0.065	2.90	—	—
March	0.076	3.18	—	—
MA 1	—	—	0.543	5.91
MA 2	0.200	2.04	0.395	4.03
MA 3	0.196	1.98	0.569	6.25
MA 16	–0.372	3.54	—	—
Adjusted R^2	0.882		0.751	
SEE	0.059		0.084	
Durbin-Watson	1.745		1.986	
# Observations	102		102	
Sample Period	10/92–3/01		10/92–3/01	

Appendix D:
Air Force EEWS and GSA Forecasting Models

Air Force EEWS

Figure D-1 is a flowchart describing the Air Force EEWS. It includes an Air Force Module with GSMA and GSFA forecasting models for net[1] contracts and an Economy Module. These would be used to generate Air Force Recruiting Risk Reports each month.

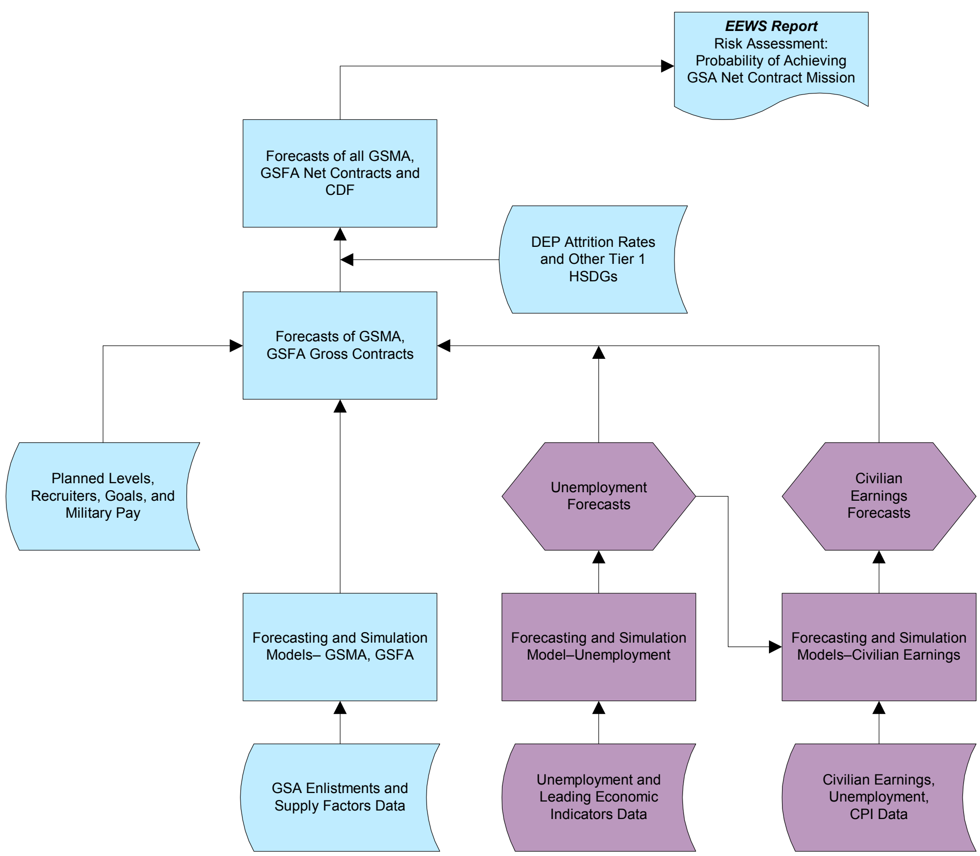

Figure D-1. Air Force Enlistment Early Warning System

[1] Unlike the Army, the Air Force assigns a mission for contracts net of DEP attrition. Consequently, the Air Force EEWS forecasts net contracts and compare that with the net contract mission.

Air Force GSMA and GSFA Models

The Air Force models are specified in Table D-1. The explanatory variables include relative military pay, unemployment, recruiters, goals, dummies for outliers (which we believe occurred because of policy changes), dummies for months, and moving average (MA) terms.

Table D-2 reports estimates of GSMA models estimated with data from the 1980s (Model 1), 1990s (Model 2), and both periods (Model 3). We included a dummy variable for the 1990s to test for a regime change (FY94). We found a regime change of –0.154, which is much smaller than the Army's (-0.42) or Navy's (-0.27).

We used the 1980s model to forecast FY 1989–FY 2000.[2] It is interesting to note a different pattern of over-predictions than we found for the Army and Navy (Figure D-2). The errors *rose and then fell* between FY 1990 and 5/94; after that they were positive but relatively small.

Given the pattern of forecasting errors, we used the data starting in 6/94 to estimate GSA models for the Air Force. These models, estimated with data through 3/01, are given in Table D-3.

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[2] To show that the 1980s model forecasts accurately in FY 1989, we included FY 1989 in the forecasting test for the Air Force model.

Table D-1. Specification of Air Force Models

Variable	Definition	Data Source/Period
GSMA	Gross contracts; NPS male, 1–3A, HSDGs + HSSRs	DMDC; 10/78–3/01
GSFA	Gross contracts; NPS female, 1–3A, HSDGs + HSSRs	DMDC; 10/92–3/01
Military Pay	$BPY_1 + BPY_2/1.3 + BPY_3/1.3^2 + BPY_4/1.3^3$, where BPY = expected basic pay @ actual TIG Air Force; 5-month moving average centered on the current month	BPY from OUSD/Comp 1/70–3/01; TIG from OSD/EPM 10/71–9/99
Civilian Pay	$CPY_{18} + CPY_{19}/1.3 + CPY_{20}/1.3^2 + CPY_{21}/1.3^3$, where CPY = average annual earnings of high school graduates who work full time (males or females); 5-month moving average centered on the current month	Current Population Surveys (monthly earnings files); from NBER 1/79–12/99, from CPS Web site 1/00–3/01
Relative Military Pay	Military Pay ÷ Civilian Pay	Computed
Unemployment	Unemployment rate for total civilian labor force	CPS/BLS; 1/70–3/01
Recruiters	Production recruiters	AFRS; 1/76–3/01
GSMA Goal	Total NETRES goal (monthly) × percent male accessions (FY) × percent HSDG 1–3A accession goal (FY) ÷ production recruiters	AFRS; 1/76–3/01
Other Goals—GSMA	Total NETRES goal – GSMA goal	AFRS; 1/76–3/01
GSFA Goal	Total NETRES goal (monthly) × percent female accessions (FY) × percent HSDG 1-3A accession goal (FY) ÷ production recruiters	AFRS; 1/76–3/01
Other Goals—GSFA	Total NETRES goal – GSFA goal	AFRS; 1/76–3/01
D786, D886, D1098, D600, D700	Categorical variables equal to 1 in specified month and year (MM/YY); 0 otherwise; outlier	Computed
D588	Categorical variable equal to 1 in 5–7/88; 0 otherwise; outlier	Computed
FY94	Categorical variable equal to 1 starting in 6/94; 0 otherwise	Computed
Monthly Dummies	Categorical variables equal to 1 in a month; 0 otherwise	Computed
MA t	Moving average error term variables, lag = t	Computed

Notes: AFRS = Air Force Recruiting Service; BLS = Bureau of Labor Statistics; CPS = Current Population Survey; DMDC = Defense Manpower Data Center; EPM = Enlisted Personnel Management; HSDG = High School Degree Graduate; HSSR = High School Senior; NBER = National Bureau of Economic Research; NPS = Non-Prior Service; NRC = National Research Council; OSD = Office of the Secretary of Defense; OUSD = Office of the Under Secretary of Defense; TIG = Time In Grade.

Table D-2. Estimates of Air Force GSMA Models

	Model 1 FY 80–88		Model 2 6/94–3/01		Model 3 FY 80–88; 6/94–3/01	
Variable	Coefficient	*t*-value	Coefficient	*t*-value	Coefficient	*t*-value
Constant	–4.020	1.73	4.573	4.28	–0.757	0.57
Relative Military pay	0.492	1.29	0.780	2.95	0.390	1.85
Unemployment	0.760	4.97	0.140	0.96	0.649	7.08
GSMA Goal	0.312	3.78	0.365	3.60	0.331	5.42
Other Goals—GSMA	—	—	–0.348	2.82	—	—
Recruiters	1.067	3.58	0.387	2.82	0.775	6.34
FY94	—	—	—	—	–0.154	2.80
Rho	—	—	—	—	0.318	4.19
Adjusted R^2	0.796		0.880		0.958	
SEE	0.084		0.046		0.076	
Durbin-Watson	1.905		1.979		1.965	
# Observations	108		82		190	
Error Structure	MA 1, 9		MA 6, 8, 10		Auto-regressive (1)	

Note: Dummy variables for policy changes and seasonality are not reported.

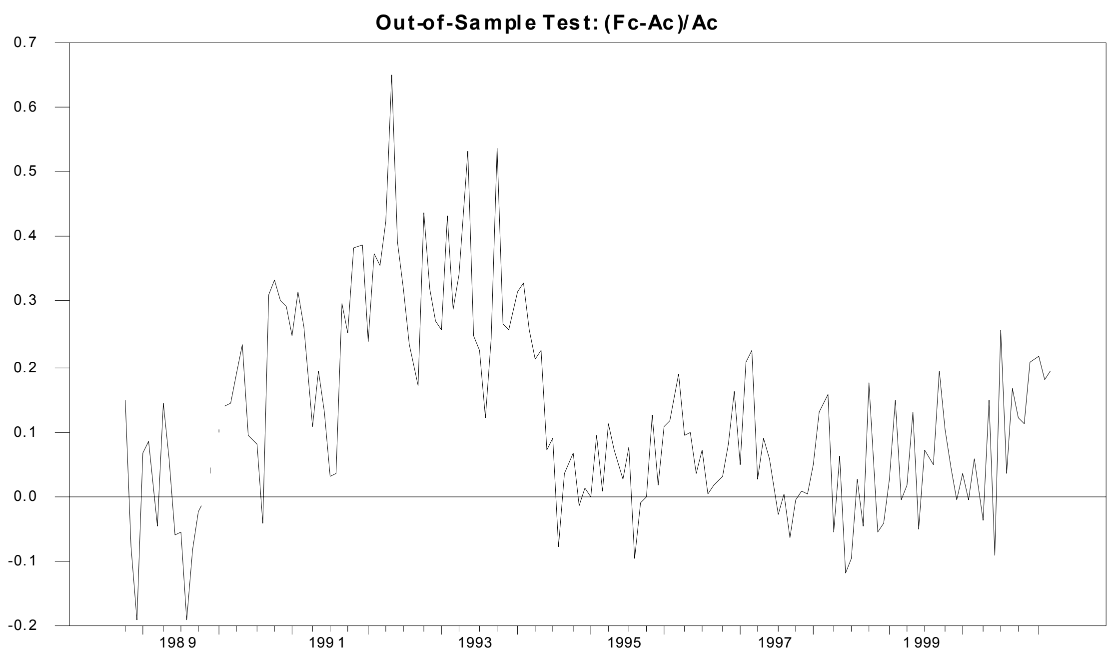

Figure D-2. Model 1 Out-of-Sample Forecasting Errors (%)

Table D-3. Air Force GSMA and GSFA Models

	GSMA		GSFA	
Variable	Coefficient	*t*-value	Coefficient	*t*-value
Constant	4.573	4.28	3.662	2.30
Relative Military Pay	0.780	2.95	0.175	0.41
Unemployment	0.140	0.96	0.727	4.73
GSMA Goal	0.365	3.60	—	—
Other Goals—GSMA	–0.348	2.82	—	—
GSFA Goal	—	—	0.214	1.00
Other Goals—GSFA	—	—	–0.115	0.50
Recruiters	0.387	2.82	0.262	1.32
D1098	–0.154	3.38	—	—
D700	–0.196	3.74	—	—
May	–0.128	4.24	–0.124	3.42
July	0.085	3.12	—	—
August	0.208	7.24	0.129	4.41
September	0.101	3.98	—	—
October	–0.069	2.70	–0.138	3.41
November	–0.095	3.52	–0.154	4.34
December	—	—	–0.061	1.87
January	0.061	2.21	—	—
February	0.048	1.72	—	—
March	0.069	2.32	—	—
MA 1	—	—	0.252	2.10
MA 2	—	—	0.374	3.25
MA 6	–0.808	5.18	—	—
MA 8	–0.547	3.72	—	—
MA 10	–0.717	4.58	—	—
Adjusted R^2	0.880		0.748	
SEE	0.046		0.076	
Durbin-Watson	1.979		1.912	
# Observations	82		82	
Sample Period	6/94–3/01		6/94–3/01	

Appendix E:
Marine Corps EEWS and GSA Forecasting Models

Marine Corps EEWS

Figure E-1 is a flowchart describing the Marine Corps EEWS. It includes a Marine Corps Module with GSMA and GSFA forecasting models for net[3] contracts and an Economy Module. These would be used to generate Marine Corps Recruiting Risk Reports each month.

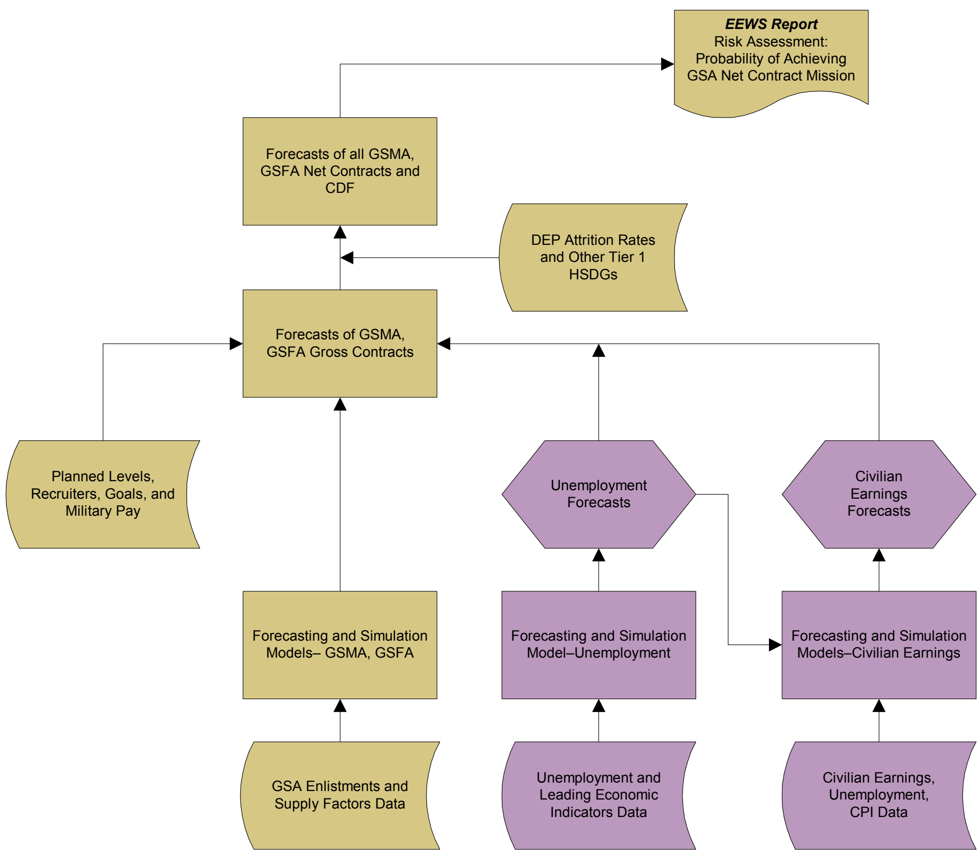

Figure E-1. Marine Corps Enlistment Early Warning System

[3] Unlike the Army, the Marine Corps assigns a mission for contracts net of DEP attrition. Consequently, the Marine Corps EEWS forecasts net contracts and compare that with the net contract mission.

Marine Corps GSMA and GSFA Models

The Marine Corps models are specified in Table E-1. The explanatory variables include relative military pay, unemployment, recruiters, goals, Marine Corps bonuses, dummies for outliers (which we believe occurred because of policy changes), dummies for months, and moving average (MA) terms.

Table E-2 reports estimates of GSMA models estimated with data from the 1980s (Model 1), 1990s (Model 2), and both periods (Model 3). We included a dummy variable for the 1990s (FY93) to test for a permanent regime change like we observed for the other services. The variable was not significant and it was dropped.

To examine the regime change issue further, we also forecasted GSMAs in 10/88–3/01 with Model 1 (Figure E-2). Compared to the other services, the pattern of the forecasting errors is different. For the other services, Model 1 generally *over-predicts* enlistments after FY 1989. For the Marine Corps, the model *under-predicts* enlistments early and late in the forecast period! Rather than a permanent negative regime change, it appears that some variables have been omitted that temporarily *increased* production early and late in the forecast period.

Since there was no permanent regime change, we compared a 1990s model for GSMAs (Model 2) versus a pooled model (Model 3). Validation tests in 4/00–3/01 indicated that the 1990s model forecasted more accurately.

Table E-3 reports GSMA and GSFA models estimated with data for 10/92–3/01 that were chosen for the Marine Corps EEWS.

Table E-1. Specification of Marine Corps Models

Variable	Definition	Data Source/Period
GSMA	Gross contracts; NPS male, 1–3A, HSDGs + HSSRs	DMDC; 10/78–3/01
GSFA	Gross contracts; NPS female, 1–3A, HSDGs + HSSRs	DMDC; 10/92–3/01
Military Pay	BPY_1+BPY_2/1.3+BPY_3/1.3^2+BPY_4/1.3^3, where *BPY* = expected basic pay @ actual TIG Marine Corps; 5-month moving average centered on the current month	*BPY* from OUSD/ Compensation 1/70–3/01; TIG from OSD/EPM 10/71–9/99
Civilian Pay	CPY_{18} + CPY_{19}/1.3 + CPY_{20}/1.3^2 + CPY_{21}/1.3^3, where *CPY* = average annual earnings of high school graduates who work full time (males or females); 5-month moving average centered on the current month	Current Population Surveys (monthly earnings files); from NBER 1/79–12/99, from CPS Web site 1/00–3/01
Relative Military Pay	Military Pay ÷ Civilian Pay	Computed
Unemployment	Unemployment rate for total civilian labor force	CPS/BLS; 1/70–3/01
Recruiters	Production recruiters	MCRC; 1/76–3/01
GSMA Goal	Total force net contract goal × percent of accession goal accounted for by GSMA enlistment ÷ production recruiters	MCRC; 10/78–3/01
GSFA Goal	Total force net contract goal × percent of accession goal accounted for by GSFA enlistment ÷ production recruiters	MCRC; 10/78–3/01
MCBONUS	Total Marine Corps bonus obligations ($000) ÷ CPI	MCRC; 10/78–3/01
D894	Categorical variables equal to 1 in 8–10/94; 0 otherwise; outlier	Computed
D1195	Categorical variable equal to 1 in 11/95; 0 otherwise; outlier	Computed
D598	Categorical variable equal to 1 in 5/98; 0 otherwise; outlier	Computed
FY93	Categorical variable equal to 1 starting in FY93; 0 otherwise	Computed
Monthly Dummies	Categorical variables equal to 1 in a month; 0 otherwise	Computed
MA *t*	Moving average error term variables, lag = *t*	Computed

Notes: BLS = Bureau of Labor Statistics; CPI = Consumer Price Index; CPS = Current Population Survey; DMDC = Defense Manpower Data Center; EPM = Enlisted Personnel Management; HSDG = High School Degree Graduate; HSSR = High School Senior; MCRC = Marine Corps Recruiting Command; NBER = National Bureau of Economic Research; NPS = Non-Prior Service; OSD = Office of the Secretary of Defense; OUSD = Office of the Under Secretary of Defense; TIG = Time In Grade.

Table E-2. Estimates of Marine Corps GSMA Models

	Model 1 10/79–9/88		Model 2 10/92–3/01		Model 3 10/79–3/01	
Variable	Coefficient	*t*-value	Coefficient	t-value	Coefficient	*t*-value
Constant	0.097	0.04	1.987	0.89	3.230	2.97
Relative Military Pay	1.295	5.41	0.322	1.76	1.293	9.56
Unemployment	0.241	2.35	0.162	1.89	—	—
GSMA Goal	—	—	0.173	2.84	—	—
Recruiters	0.904	3.40	0.643	2.40	0.567	4.13
MCBONUS	—	—	0.028	1.96	—	—
FY93	—	—	—	—	—	—
Adjusted R^2	0.909		0.925		0.898	
SEE	0.072		0.042		0.066	
Durbin-Watson	1.755		1.837		1.831	
# Observations	108		102		258	
Error Structure	MA 1, 2, 3, 12		MA 1, 3, 6, 10		MA 1, 2, 3, 12	

Note: Dummy variables for policy changes and seasonality are not reported.

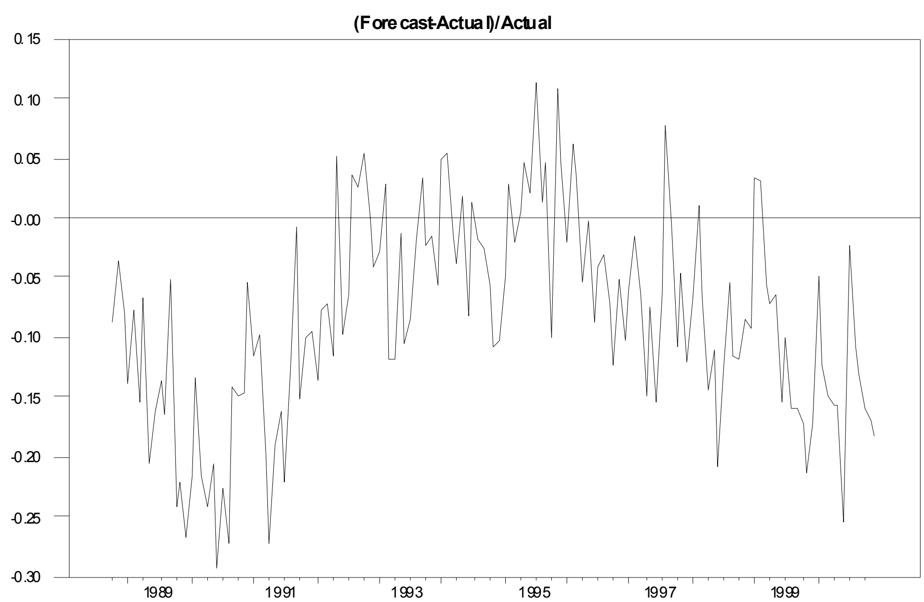

Figure E-2. Model 1 Out-of-Sample Forecasting Errors (%)

Table E-3. Marine Corps GSMA and GSFA Models

	GSMA		GSFA	
Variable	Coefficient	*t*-value	Coefficient	*t*-value
Constant	1.987	0.89	–22.691	4.92
Relative Military Pay	0.322	1.76	—	—
Unemployment	0.162	1.89	0.680	4.55
GSMA Goal	0.173	2.84	—	—
GSFA Goal	—	—	0.100	1.20
Recruiters	0.643	2.40	3.378	5.98
MCBONUS	0.028	1.96	0.064	2.31
D894	—	—	–0.194	3.78
D1195	–0.140	3.30	—	—
D598	—	—	–0.351	4.74
June	0.498	24.22	0.182	7.13
July	0.396	18.21	0.142	4.18
August	0.374	16.41	0.180	5.08
September	0.256	10.45	0.131	3.73
October	0.213	11.54	0.140	6.71
November	0.192	9.28	—	—
December	0.187	8.46	0.033	2.87
January	0.234	12.16	—	—
February	0.147	6.51	—	—
March	0.144	7.02	0.118	5.54
MA 1	0.213	2.06	0.622	4.99
MA 3	0.353	3.19	0.292	2.46
MA 4	—	—	0.757	6.26
MA 10	–0.293	2.44	—	—
MA 11	—	—	0.756	5.37
Adjusted R^2	0.925		0.760	
SEE	0.042		0.069	
Durbin-Watson	1.837		2.043	
# Observations	102		102	
Sample Period	10/92–3/01		10/92–3/01	

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Abbreviations

ACF	Army College Fund
AFQT	Armed Forces Qualification Test
AFRS	Air Force Recruiting Service
ARIMA	Auto-Regressive Integrated Moving Average
ASVAB	Armed Services Vocational Aptitude Battery
AVF	All-Volunteer Force
BLS	Bureau of Labor Statistics
BP	Basic Pay
CDF	cumulative distribution function
CPI	Consumer Price Index
CPS	Current Population Survey
DAPE-MPA	Office of the Deputy Chief of Staff for Personnel
DEP	delayed entry pool
DMDC	Defense Manpower Data Center
DoD	Department of Defense
EEWS	Enlistment Early Warning System
EPM	Enlisted Personnel Management
ERL	Economic Research Laboratory
GED	Graduate Equivalency Diploma
GSA	Graduate or Senior 1–3A
GSB	Graduate or Senior 3B
GSFA	Graduate or Senior Female 1–3A
GSMA	Graduate or Senior Male 1–3A
HQDA	Headquarters, Department of the Arm
HSDG	high school diploma graduate

HSSR	high school senior
IDA	Institute for Defense Analyses
LEI	Leading Economic Indicators
MA	moving average
MCRC	Marine Corps Recruiting Command
MDEP	Management Decision Package
MGIB	Montgomery GI Bill
MORS	Military Operations Research Society
MOS	Military Occupational Specialty
NBER	National Bureau of Economic Research
NPS	non-prior service
NRC	Navy Recruiting Command
OSD	Office of the Secretary of Defense
OUSD	Office of the Under Secretary of Defense
PPBS	Planning, Programming and Budgeting System
QMA	qualified military available
RMC	Regular Military Compensation
SEE	Standard Error of the Estimate
TIG	time in grade
TOS	term of service
TSCS	time-series cross-sectional
USAREC	U.S. Army Recruiting Command
YOS	years of service
USAREC	U.S. Army Recruiting Command

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14. ABSTRACT
The Army adds recruiting resources too slowly during economic expansions and over-budgets during recessions. This leads to accession crises and waste. An alternative is Crisis Prevention Management, which uses forecasts of enlistments to allocate resources as needed over the business cycle. To provide the forecasts, we constructed an Enlistment Early Warning System (EEWS) for the Army. Each month the EEWS forecasts enlistment contracts over the next year. Forecasts are based on time-series models estimated with national monthly-level data. Validation tests show the forecasts are extremely accurate. To test the sensitivity of the methodology, we also developed and validated models for the other military services. The Army is now using the EEWS to help manage recruiting incentive programs and to estimate the effects on enlistments of the economy, policy changes, and "shocks" such as the September 11th terrorist attacks.

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